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THE DINOSAUR BEDS OF THE GRAND RIVER VALLEY OF COLORADO.*

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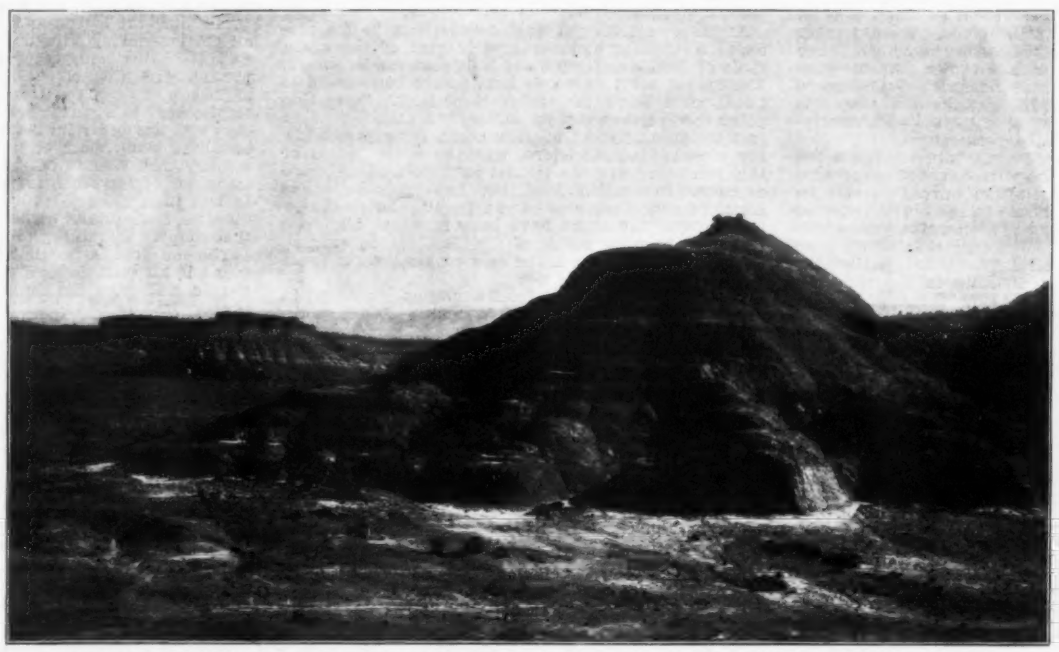
DURING the spring of 1899, while in correspondence with Dr. S. M. Bradbury, President of the Western Colorado Academy of Science, the writer's attention was called to the occurrence of vertebrate fossils in the valley of the Grand River. The presence of these fossils had been locally known for about fifteen years and they had been more or less collected as curios, but no paleontologist had investigated the matter and no report of their presence had been given to the scientific world. Knowing that the older collecting grounds for Dinosaur fossils were rapidly being culled, and aware of the possible importance of discovering a new field, plans were at once made looking toward the investigation of this locality. However, it was not until the following spring that a museum expedition could be organized and sent into this region for the purpose of collecting fossils. The three months so employed yielded such important returns that early in the past year the work was resumed with equally gratifying results.

The Jurassic† formations of the Grand River Valley were originally described by Peale‡ in the Survey of Colorado, but some further description, based upon observations made during the two summers spent there, and illustrated with photographs by Mr. H. W. Menke of the Museum, may be of interest.

On the southern bank of the Grand River the Uncompahgre Plateau breaks away in a series of benches and folds to the level of the valley below. The western half of this plateau is made up chiefly of the Jurassic and Triassic formations, although retaining in many places a capping of lower Cretaceous. Farther west the Valley of the Dolores has cut through these formations into the underlying Carboniferous. In the cañons formed by its tributaries, as well as those of the Grand River, the whole depth of the Jura-Trias is exposed.

Approached from the Grand River Valley, the most conspicuous landmark is the high and abrupt Triassic bluff which forms the valley's southern confin[illegible]. For several miles to the southward the massive red sandstone has been denuded of its Jurassic covering and so has received the name of Red Mesa. Some distance from the face of this bluff isolated buttes and ridges of Jurassic clays appear, and farther still to the southward the whole thickness of this formation is exposed in the fantastically weathered shapes of typical bad lands. The top of the Jurassic strata is covered with a heavy growth of pines and hence is geographically known as Piñon Mesa. All of these strata dip in a general way to northeast and with the Book Cliffs, which bound the valley on the north, form a great monocline. This is, however, varied by many local complications.



BAD-LAND WEATHERING IN VARIEGATED JURASSIC CLAYS, WITH TYPICAL BUTTE CAPPED WITH DAKOTA SANDSTONE APPEARING IN THE DISTANCE.

FANTASTIC WEATHERING OF TRIASSIC SANDSTONE AS EXPOSED IN MONUMENT PARK. THE UNDERLYING GRANITE APPEARS IN THE FOREGROUND.

Along the lower course of the Gunnison River, the strata forming the crest of the Piñon Mesa sweep down to the valley level in a great undulating fold. In this the Jura-Trias has been but little broken or crumpled, although it is now deeply furrowed by later cañons of erosion. Here the Jurassic clays, protected by a heavy capping of Dakota sandstone, extend quite to the river bank. A few miles west of Grand Junction, however, this fold gives place to a fault of more than one thousand feet. Farther along the line of bluffs to the northwestward the strata are again continuous in a more or less interrupted fold until at a point sixteen miles west of the mouth of the Gunnison the crest of this fold is broken by a fissure through which the Grand River has cut its cañon.

Along the line of this fault the Triassic sandstone is exposed in an almost perpendicular bluff standing high upon a bench of igneous rocks consisting chiefly of a coarse-grained granite. Against this igneous bench occasional masses of Triassic sandstone lie tilted at high angles. A short distance toward the river the Trias resumes its almost horizontal position and still nearer the river appears a series of Jurassic bluffs facing the line of fault and dipping in the general direction of the monocline.

In this region the Trias is represented by a massive ledge of reddish sandstone, slightly crossbedded, and weathering in peculiar pinnacle and dome-like shapes. Below this is a softer stratum of vermilion-colored sandy shales resting directly upon the igneous rocks. The whole thickness of these ledges is about 400 feet.

The Jurassic strata range from 600 to 700 feet in thickness and may admit of four subdivisions. The lower or marine Jura is from 100 to 120 feet in thickness and consists of bluish and grayish gypsum-bearing clays in which thin layers of fine-grained sandstone and nodular ledges of limestone are interspersed. The latter are never more than six or eight inches in thickness and are usually from three to five in number. In no instance were fossils found in these measures. The change from marine to fresh-water Jura is scarcely noticeable and can be traced only by the absence of limestone and the more homogeneous and massive nature of the clays. There is, however, near the base of the fresh-water formation a ledge of fine-grained brown sandstone which is noticeable from its peculiar honeycomb weathering.

Above the marine Jura lies a stratum of greenish clay shale about 100 feet in thickness. It contains occasional ledges of homogeneous green sandstone and a few layers of clay nodules, but nowhere is there a marked color-banding. Above the green shale, which may be spoken of as the lower beds, comes a darker zone of 40 or 50 feet containing frequent ledges of cross-bedded sandstone. These vary from a fine-grained sand occurring in thin layers to a massive coarse-grained sandstone, rich in iron and weathering to a brownish red color. The latter sometimes reaches a thickness of 20 feet toward the western end of the exposures

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* From Field Columbian Museum Publication No. 60, Geological Series.

† These beds have been variously designated as: "Lower Dakota Group" (Peale, United States Geological and Geographical Survey of Colorado and Adjacent Territory, p. 179); "Atlantosaurus Beds" (Marsh, American Journal of Science, third series, vol. xxi., p. 417), and "Como Beds" (Scott, An Introduction to Geology, p. 477; Williston, American Journal of Science, fourth series, vol. xi., p. 114). While the consensus of opinion among later writers would place the fresh-water deposits in the lowermost Cretaceous, contemporary with the English Wealden, for reasons which will later appear they will be referred to in this article as Jurassic.

‡ Peale op. cit., p. 170-180.

described. Throughout the series there is a noticeable tendency toward thinning out and being replaced at slightly different levels. In places the sandstone disappears entirely and the green shales below grade into the banded clays above.

The variegated clays reach a thickness of 300 or more feet and are conspicuous on account of their brilliant horizontal banding as well as the typical badland shapes into which they weather. The alternation between green and purplish bands does not mark any variation in the nature of hardness of these massive joint clays. There are frequent layers of clay nodules, sometimes calcareous, and a few ledges of nodular gray sandstone which are confined to limited areas. Occasional thick ledges of cross-bedded sandstone and lenticular masses of greenish sand occur at almost all levels, but these are likewise of limited extent. Throughout the lower measures of this horizon are abundant nodules of secondary formation, sometimes occurring in regular strata, but often scattered promiscuously through the clays. Near the top the banding is least pronounced, and the clays take on a more sandy nature. Just below the capping ledge of sandstone there is often a thin stratum of darker shale which bears traces of carbonaceous matter; at other places it takes on a mottled color and a pebbly texture.

The Jurassic clays are capped by a massive ledge of sandstone varying in this locality from ten to twenty feet in thickness. It is coarse-grained in texture and abounds in quartzitic nodules, often so massive as to occupy the greater part of the ledge. When freshly broken it has a decided yellowish color, but after weathering it changes to a dark brown. At the base there is often a stratum of fine-grained and more homogeneous sandstone. In certain localities this ledge contains the wealth of fossil leaves which everywhere distinguishes the Dakota sandstone.

With regard to the line of demarkation between the Jurassic and Cretaceous, the writer cannot agree with the determination of the Hayden Survey in this locality. Writing of the Jurassic in the upper valley of the Gunnison, Peale says:* "The massive yellow silicious sandstone, in some places quartzitic, at the base of the Cretaceous, is so well defined lithologically that there has never been any difficulty in separating it from the overlying shales. Along the edge of the plains in Colorado it is underlaid by greenish, shaly beds, sometimes lignitic toward the top, generally in part or wholly covered, which have always been referred to the upper part of the Jurassic." This description will apply to the same formation in the Grand River Valley, but writing of the Grand River Valley a year later the same writer says: "The line separating the Jurassic from the overlying Dakota is indefinite."† The following section referred to the Cretaceous shows how far he has digressed from the conclusions of the previous year:

The following is the average of the Dakota group in the hog-backs of the Grand River:

1.	Massive yellow silicious sandstone with faint impressions of dicotyledonous stems at some localities.....	90-200
2.	Variegated marls with bands of reddish sandstone. These beds have the characteristic weathering of bad lands.....	
3.	Dark colored sandstones with bands of marls and shales. Near the base a layer containing nodules in which there are jaspers.....	50-100
	Total thickness.....	140-300

In this section the massive sandstone ledge is the characteristic Dakota sandstone referred to in the eastern Gunnison region as marking the base of the Cretaceous. From its well-known lithological character, as well as the abundance of dicotyledonous leaves found in it, there can be no doubt that it is the same which caps the Como Beds‡ at Canon City and Trinidad, in Colorado, and at Como Bluff and in the Freezeout Hills of Wyoming. In fact, so persistent is this ledge and so marked is its effect upon the land sculpture, owing to its resistance to erosion, that it has come to be expected as a capping ledge wherever the beds occur. The variegated marls have the same lithological characters as the upper measures of Como Bluff and have been lately reported§ from Trinidad, Colorado.

The dark colored sandstones described under 3, though persistent at approximately the same level, are by no means continuous. The writer has traced this level from the valley of the Gunnison to the point where Grand River enters the cañon, and in a distance of twelve miles these ledges thin out and reappear no less than five times. At the mouth of the Nothoroughfare Cañon, the sandstone strata are wanting entirely and the clays show not only a continuous deposition from the marine Jura to the base of the Dakota sandstone, but the color-banding grades evenly from the green shale below to the banded clays above. The same is quite as true at other points where the sandstone ledges thin out.

Moreover, the characteristic fossils of the Como Beds occur more abundantly in the variegated clays than in the green shales below. Nowhere are they so abundant as in the cross-bedded sandstone ledges. Representatives of a single genus (*Morosaurus*) have been observed to range through the entire series. It is therefore evident that no important sub-division can be made of these beds. Whether Jurassic, as they have been usually considered, or lowermost Cretaceous and contemporary with the Wealden, as held by some, these measures should be regarded as identical with the Como Beds and treated as a close series having only such sub-divisions as are here suggested. And if stratigraphy is of any value in determining the relationships of formations, the closely connected series of sediments extending from the base of the marine Jura to the base of the Dakota sandstone certainly has a story to tell. Here, as in many localities observed throughout the States of Colorado and Wyoming, the marine Jura and the fresh-water beds are so intimately related as to admit of no hiatus. If it then be proved that the relations of the fresh-water fauna to that of the Wealden indicate contemporaneity rather than an accelerated development of reptilian life in America, as might well be the case, we must conclude that the barren zone of green clays lying between the marine Jura and the fossil-bearing horizon has bridged the gap between Jurassic and Cretaceous.

From their lithological characteristics, as well as the nature of their weathering, the variegated clays might well be mistaken for Eocene bad lands. They are made up of the same sort of indurated clays, firm as sandstone under the pick, but readily dissolved and yielding rapidly to erosive agencies. There is also the same brilliant horizontal banding, the same nodular layers, the same cross-bedded and interrupted ledges of sandstone, and the same variation of hard and soft strata which gives the characteristic bench-like profile common to these formations. In short, so close is the resemblance to the Wind River Eocene of central Wyoming that were it not for the fossils one might be justified in regarding the two as identical.

The fossils found in this region are, with few exceptions, vertebrate. One invertebrate fossil (*Viviparus*) is found abundantly in one or two localities and is of interest in being chalcedony-filled. The vertebrates so far as observed, are confined to the order Dinosauria, but are quite abundant. The forms are the common types of the Como Beds as found in eastern Colorado and in the well-known localities of central and southern Wyoming.

As before stated, the marine beds have so far produced no fossils, and the greater part of the green shale of the lower fresh-water beds seems to be barren. The lowest point at which fossils have been found is twenty feet below the top of these beds. From this point upward they rapidly increase in abundance. In fact the thin stratum of dark shale, lying just below the cross-bedded sandstone, and the lower ledges of this sandstone are the richest in fossils of all these deposits. In certain localities, however, the whole series of sandstone abounds in fossils. In the variegated clays, Dinosaurs have been found at all levels from the base to within a few feet of the capping Dakota sandstone, but are usually confined to the lower 150 feet.

No general deposits of fossils such as are found in eastern Colorado and southern Wyoming have been discovered in this locality. In the clays seldom more than one individual is found in a place and these have the bones but little displaced from their relative positions. This fact, as well as the homogeneous nature of the clays, suggests that their deposition took place in comparatively still, if not deep water. In the sandstone ledges, however, the positions of the bones show that they have been carried about. Rarely more than the parts of a leg or a short series of vertebræ have been found connected, and more often isolated bones are found. This, taken in connection with the varying coarse and fine-grained sands and the persistent cross-bedding, is conclusive evidence of deposition by water currents. In fact the abundance of fossils in certain pockets of this sandstone and the manner of their occurrence are very similar to those of the Metamynodon Beds of the White River Oligocene in South Dakota. The sandstone ledges are of course more massive, but in their relation to the clays above and below there is evidence of a similar set of conditions. The varying clays with the horizontal banding and frequent nodular ledges also correspond closely to the clays comprising the Oreodon Beds of the White River.

Let us attempt to trace the history of the Jurassic formation as evidenced by the nature of the rocks, the stratigraphy and the occurrence of fossils: Given an arm of the Jurassic sea, fed by rivers and open to the ebb and flow of tide waters. Under these conditions the sediments washed down by the river everywhere accumulated slowly, and alternating with them thin ledges of limestone and gypsum were laid down. Occasional strata of sand accumulated by the action of retarded currents about the estuaries of streams. Later, by some change in levels, the ingress of sea water was cut off, but the outlet still remained and so ensued the gradual change from salt to fresh water. Then followed a period of comparatively uninterrupted deposition in which the green shale was laid down under still water. Along with it were deposited near the mouths of streams the occasional homogeneous beds of green sand. As the basin filled up and its outlet deepened, the lake became shallower until its bed was invaded by the shifting channels of broad and shallow streams. Its sand-bars have formed the cross-bedded sandstone ledges which mark the transition from the lower to the upper clays. With the shallower waters came the great land and shore reptiles and about the estuaries of streams their remains were deposited abundantly.

Again the lake waters invaded the region and the deposition of sand in this locality was cut off. The period following was one of greater changes and probably of slower deposition than that preceding the river period. The presence of fine reeds or sedges shows that the water was shallow, at least in places, and parts of skeletons found on irregular surfaces imbedded in these reedy clays, suggest mud-bars or islands on which they have stranded. In one instance part of a skeleton found imbedded in a stratum of blue clay which thinned out and was replaced by sandstone with pebbles at the base, indicates that the carcass was buried in a mud-bank bordering a stream or water-current. The interruption of the vertebral column and the displacement of the ribs in one direction show that the stream was sufficient to carry away the missing part of the skeleton.

The tendency toward a more shaly nature and the presence of carbonaceous matter in the upper measures indicate the return of shallows and the greater abundance of vegetable matter. This condition evidently culminated in the great influx of sand laden with deciduous leaves which marks the period represented by the Dakota sandstone.

* U. S. Geological and Geographical Survey of Colorado and the Adjacent Territory, 1875, p. 88.

† U. S. Geological and Geographical Survey, 1876, p. 180.

‡ Scott, An Introduction to Geology, p. 477; Williston, Amer. Jour. Science, Vol. XL., p. 114.

§ Lee, Journal of Geology, No. 4, 1901.

Anemia Mixture.—

Ferri ammon. cit.....	5 grains
Spt. chloroformi	10 minims
Aq. ad.....	½ ounce

M. Ft. haust. Ter die sd.—Chem. and Drug.

MOSQUITOES ATTRACTED BY SOUNDS.

DR. S. M. LAWRENCE (Port of Spain, Trinidad) writes to the British Medical Journal concerning the fact observed by a correspondent to that paper that certain sounds attract mosquitos. Dr. Lawrence says that in his childhood days, with others, a favorite amusement at dusk was to attract and kill mosquitoes by these means. His companions and he would vie with each other in hitting off the note that would prove most attractive to these pests, which so far as he can remember was a continuous "oo" pitched in a medium key, and then suddenly changed to a lower "ah," drawn out in the same way. Most vivid—proceeds Dr. Lawrence—is the recollection of the sudden rise in the volume of their noise, and the equally sudden attack on the face as they promptly answered the invitation. He often had recourse to this ruse, not only for amusement, but also to put a stop to their unwelcome attentions.

THE MUSKRAT—PRINCIPAL FUR PRODUCER IN N. AMERICA.

RECENT heavy rains in the eastern part of the United States have enabled the hunters of muskrats to secure unusually large numbers of these animals. The high water has driven them from their semi-aquatic haunts, and hundreds of thousands of pelts have been added to the already large catch for the present season.

The muskrat is the most important numerically of all the fur-bearing animals in the United States, about 4,000,000 skins being secured each year, and, with the possible exception of the mink, it also ranks first in aggregate value of the dressed skins. Its capture gives employment to a greater number of persons than is the case with any other fur-bearing animal, fully 6,000 men and boys being more or less actively engaged in this country each year in taking the muskrat, whereas the slaughter of fur seals, for instance, gives employment to less than 200 residents of the United States. The muskrat is also quite numerous in Canada, the yield in that country amounting to about 1,250,000 annually.

The muskrat is peculiar to North America, and is found in all suitable localities from the Atlantic to the Pacific, and from the Gulf of Mexico to the northern timber limit in Canada, tenanting the shores of countless lakes, the banks of the many rivers, and the oozy swamps and muddy, stagnant pools. It is probably most abundant in the Chesapeake region, and in Missouri, Minnesota, and Manitoba. It thrives even in thickly populated localities and the vicinity of large cities. A well-known instance of this is its abundance in the Hackensack meadows, which separate Newark and Jersey City, N. J., where the dome-shaped houses form one of the interesting sights from the railway trains. In some of the lakes of Missouri and the marshes of the Chesapeake region these houses are so numerous as to resemble a prairie-dog town on the Western plains.

Although frequently seen swimming and feeding in the daytime, the muskrat is nocturnal in its habits, spending the greater part of the day during the summer in burrows in the banks of rivers and ponds, each burrow consisting of a chamber with numerous exits under the surface of the water. During the winter it lives in a cone-shaped hut or house built during the fall among the waving flags in the marshes. These houses are made of roots, flags, grasses, and small pieces of water-soaked wood, all cemented together by a sort of mortar made of clay and mud. While comparatively smooth and even on the inside, they are rough on the outside and resemble somewhat the haycocks on newly mown meadows. They are located in water varying from 2 to 4 feet in depth and are built up to the height of 2 or 3 feet above the surface of the water, leaving room for an air chamber within, which forms the nest. Thus the houses are from 3 to 6 feet in height, and each one contains from four to nine muskrats. Three or four channels or "leads" are cut in different directions from the center, for ingress and egress, the material thus displaced being used in strengthening the foundations. Below the water line the houses are of bare mud inside, with a floor of sticks and grasses a few inches above the water. They are similar to beaver lodges, but are far inferior in design, workmanship, and durability. Being roughly constructed, they are more easily repaired or replaced when damaged or destroyed.

The animal is very prolific, bringing forth from three to nine at a birth, and it is said to raise three litters in a season in some localities. Owing to this rapid multiplication, and also to its powers of hiding even in the vicinity of populous sections, the muskrat will doubtless survive for generations after the beaver, otter and mink have passed away.

The food of the muskrat is principally herbivorous, consisting of the roots and leaves of various aquatic plants, and also of many fresh-water mussels. It thrives best in sluggish streams or grass and flag-bordered ponds. Its habits, appearance, and characteristics so closely resemble those of the beaver that it is sometimes referred to as the little beaver or musk beaver. Its popular name is due to the pungent odor which originates in a thick fluid contained in two small glands. The meat is edible, and in some localities it is highly prized and regularly marketed during the season. However, it is rather too dark and flaccid to be generally popular.

The fur of the muskrat is dense and soft, resembling somewhat that of the beaver, but it is shorter and inferior in denseness, fineness, and durability. It resists the water during the life of the animal, but is readily wetted immediately after death. The color is generally of a drab-blue, in some cases with a whitish appearance, and tipped with reddish-brown. The fur is concealed by long, stiff, brown overhairs on the upper part and sides of the body. The general color of the animal is dark umber-brown, almost blackish-brown, on the back and gray below, but specimens are found ranging through the various shades of brown, blue, and yellow to pure white. The white muskrats are of no more value in the fur trade than those of the ordinary colorings, yet they are highly prized by collectors of natural history specimens. The fur of the small muskrat found in Alaska is of a light silvery color, almost white on the

abdomen, and is very fine, the pelts from that locality having been highly prized when beaver hats were in fashion.

Muskrats are not very shy and are easily captured. They are taken in various ways, mostly in steel traps baited with apple or parsnip or placed entirely without bait. The traps are placed two or three inches under water in the principal feeding places and runways. The bait should be placed six or eight inches above the trap and in such a position that the animal must pass over the latter to obtain it. The trap is secured by a chain fastened to a stake in such a position that the chain will lead the captive into deeper water and drown it. If not prevented in this manner the animal will very likely twist or gnaw the fastened leg off and escape. As soon as the animal is trapped and plunges into the water it is weighted down by the trap and drowned.

Muskrats are frequently secured by forcing a long-pronged spear or gig through the tops of their houses and transfixing the animals within. The house must be approached cautiously, for it is vacated on the slightest alarm. After each successful thrust a hole is cut through the wall of the house with a hatchet and the game removed, when the hole is filled up. As the animals are scurrying from the house after the thrust of the spear some may be taken by spearing them through the ice if the thickness of the latter does not exceed two inches. The remaining members of the family soon return and set about repairing the breach in the wall of the house. If, when the wall is breached, a trap is properly set inside the house, near the edge of the nest and a few inches under the water, the first muskrat returning is usually taken. When a trap is so set, a stick about three feet long is placed through the ring of the chain and laid across the breach in the wall.

On sunny days in winter or early spring muskrats are shot while sitting on the ice or while swimming about or basking on logs. They are also secured in the same manner on moonlight nights. Large numbers are taken in this manner by sportsmen, but it is not a desirable method of obtaining them for the fur market on account of the damage done by the shot.

In many sections of the United States, especially in Missouri and the Chesapeake region, the taking of muskrats is very extensive and furnishes employment to many hunters, some of whom depend almost entirely upon this vocation as a means of support during the winter. Frequently cabins or shanties are erected on or near the bottom lands or marshes, and during the trapping season, lasting from January 1 to March 21, the hunters spend nearly all of their time there. Some of the most successful own their own marshes and many others rent from the owners either on fur shares or for a fixed money rate. A hundred acres makes a large range for one man to hunt over, and usually upon a good marsh twenty-five acres worked thoroughly will produce as many skins as a larger area covered insufficiently. Sometimes 40,000 to 60,000 are secured on a single marsh during a season. The professional trappers are hardy fellows, who can stand almost any amount of exposure, most of them having been raised from boyhood upon the marshes. Women have also been known to prove successful as hunters, and occasionally may be seen attired in long rubber boots plunging about the marshes, spearing the animals or attending the traps. In addition to the professional hunters, large numbers of men busy themselves with trapping during the height of the season. Hundreds of boys depend on catching muskrats for their pocket money.

The proper method of skinning a muskrat is to cut the pelt at the anterior end and draw it wrong side out over the animal's head. The pelt is then stretched, with the fur side turned in, on a board stretcher, fastened with about four tacks, and suspended in a cool place until it is thoroughly cured. Some trappers cut off the feet with a hatchet, cut the skin from a point between the two teeth in the lower jaw, down the throat and chest to about two inches beyond the forelegs; the skin is then started by cutting around the lips, eyes, and ears, and is stripped, flesh side out, over the body. A stick of flexible wood, less than an inch in diameter and about three feet long, is bent in the form of an ox bow and then inserted into the skin, which is drawn tight and fastened by splitting down a sliver in the bow and inserting the edge of the skin into it. This is not so desirable as the former method, since the skins are not stretched uniformly and do not keep their proper shape or pack as well. Some trappers cut the pelts open down along the middle of the chest and abdomen and stretch them out in a flat circular form for drying similar to beaver pelts. This also is an objectionable method and is now little used.

A hundred years ago muskrat fur was little prized and the annual product was relatively small. Many farmer boys found it convenient to set a few traps, using some of the skins for making caps, gloves, etc., and sending the rest to market. The average number received on the market throughout the eighteenth century did not exceed 100,000 skins annually. During the second and third decades of the nineteenth century the output increased considerably, due principally to the greatly increased demand in hatmaking and also to the opening of new trapping territory. In 1829, for the first time, the receipts in London, the principal fur market of the world, exceeded 1,000,000 skins, the total being 1,165,663. The annual receipts thereafter fluctuated considerably, but on the whole continued to increase, exceeding 2,000,000 in 1862, 3,000,000 in 1867, and 4,000,000 in 1871. Since the year last named the price of the skins has greatly decreased but the receipts at London have been fairly constant, averaging about 3,500,000 annually.

In addition to those handled in London about 2,000,000 muskrat skins are placed on the markets each year. Of these about 1,500,000 go to Leipsic, and 500,000 are sold to the furriers of the United States and Canada without passing through the two market centers. This makes an aggregate product of 5,500,000 skins annually, of which about one-fourth are obtained from within the limits of the Dominion of Canada, and the remainder are caught in the United States. The total product of muskrat skins during the nineteenth century reaches the enormous amount of 250,000,000, sufficient to make a blanket covering nearly 4,000 acres. The area of the skins secured annually in the United States at present is approximately 70 acres, which is more than twenty times as much as that of the fur seal product.

Formerly muskrat fur was largely used as a substitute for beaver in hatmaking, forming a cheap and fairly satisfactory imitation. Owing to its scarcity in the London market it was then of much greater value than at present, selling for 40 or 50 cents per skin, even equaling the value of mink at times. The general adoption of the silk hat resulted in a great decrease in the demand, and the price fell to as low as 6 or 7 cents per skin, and trapping was of little profit. During the last sixty years muskrat skins have been used principally as dressed fur, and prepared in imitation of the more highly prized beaver, otter, and fur seal. It is about the best of all the cheap furs on the market. The present value of muskrat skins varies from 5 to 40 cents each, according to color and condition. Those from the Chesapeake average about 12 cents each for brown and 23 cents for black. The black pelts are marketed principally in Russia, where they are used for coat linings; but many are used in England, France, and America for cloaks, trimmings, gloves, etc. The price of No. 1 black skins at the last London sale averaged 1s. 3d.; in 1891 it was 1s. 7d., while in 1875 it was something over 3s. The lighter ones fetch about 7d. each.

Two or three decades ago quantities of muskrat skins were plucked and dyed to imitate fur seal, the resulting article readily deceiving the uninitiated. While the fur is soft and short, it is not as thick as that of the fur seal, and the leather is much heavier and not sufficiently strong to permit its being scraped to a suitable thinness. After a few weeks' wear the fur becomes matted down, being less elastic than fur seal. During the seventies the use of muskrats for this purpose was very extensive, especially in Europe, thus providing a large market for this abundant and easily procured fur. This substitution injured the market for fur seal, persons hesitating about paying $200 for a fur seal garment when a fairly good imitation was obtainable for one-fifth that amount. The imitation, however, was generally unsatisfactory to the trade, and on the introduction of "electric seal," made from the cony, the use of muskrat fur for this purpose was generally abandoned except for small articles, as gloves, caps, etc.

Muskrat fur is used more extensively in Europe than in America, the Russians and Germans being especially large consumers. It is employed in making gloves, collars, caps, capes, muffs, trimmings, linings, etc., and is made up either natural, plucked, plucked and pointed, or plucked and dyed black or various shades of brown. Large quantities are used as linings for overcoats and long wraps, from forty to sixty being necessary for each garment. Sometimes the under parts are used separately for this purpose, the natural white color being quite effective. The skins of young animals are especially suited for linings. The unplucked skins are frequently dyed to imitate mink, and sold as "Alaska mink," "water mink," or "black mink."—Charles H. Stevenson, in The New York Times.

THE PRINCIPAL VEGETABLE PRODUCTS OF THE HAWAIIAN ISLANDS.*

As everyone in the horticultural world knows, sugar is the staple industry, and is largely cultivated throughout the islands. It was cultivated in very small quantities before 1876, when a treaty of commercial reciprocity with the United States came into effect. Under the provisions of this treaty an era of unexpected prosperity set in, and the production of sugar, as well as rice, increased more than was ever anticipated. Large barren tracts of land were brought into cultivation by extensive irrigation, some of the ditches being 40 miles in length, carried through dense woods, tunneled through rock, and spanning wide cañons. The Ewa Plantation, near Honolulu, is one of the largest and finest in the islands. About 90,000 acres are taken up with the various plantations, with a yearly yield of about 225,000 tons of sugar. It requires an average of eighteen months for a crop to mature, the ordinary yield being 3½ tons to the acre; yet on specially rich alluvial soil it is sometimes as great as 9 tons to the acre.

Next in importance comes rice. Its culture is principally carried on by the Chinese, and in the San Francisco market it grades with the best coming from China. The ground is plowed and well harrowed, the field is then submerged, the water being allowed to stand until the crop ripens, when it is drawn off. The method of cultivating is crude and primitive. The Chinaman sows the seed thickly in a small field; when the plants are about 6 inches high they are pulled up and taken to the field for planting, where they are set out in the mud by hand in rows about 8 inches apart. When matured the water is drawn off to allow the straw to ripen. The crop is then cut with the sickle. No threshing machines are used by the Chinese rice grower, but the grain is separated from the chaff by being beaten out with the hoofs of horses or Chinese cattle, as in ancient times.

Coffee is cultivated, but not to a large extent, although Hawaian, or Kora, coffee takes a high place among the best coffees of the world; the trees are grown anywhere, from the sea level up to 3,800 feet above the sea. One of the greatest difficulties to contend with is insect blight, which is greatly kept in check by peculiar parasites, and ladybirds that have been introduced for each kind of insect. The cultivation of tea is carried on with good results, the best quality of leaf being obtained on the higher elevations. The high price of labor prevents its more extensive cultivation.

Hemp has been experimented with, and pronounced by experts to be of a good strong description. The expense of cultivation is trifling, and the yield per acre is about 13½ tons. Ramie, or vegetable silk, grows luxuriantly, but the industry is not developed owing to the want of suitable machinery.

The soil and climate of Hawaii cannot be excelled for the production of tropical and sub-tropical fruits, and their introduction has added largely to the prosperity of the islands, especially so in the case of semi-tropical fruits, such as the alligator pear, banana, lime (Citrus limetta), orange, and lemon. The alligator pear grows to a large size, and the fruit is of a superior quality. The flesh is of buttery consistency, with a nutty flavor, and it makes a delicious dressing for salads; the largest of these heads is about 6 inches long, and weighs upward of 3 pounds. The mango grows in great profusion, and several varieties are used for making chutney, the best varieties having been imported from India and Jamaica. It is an evergreen with small, glossy leaves; and a gum which exudes from the trunk of the tree is used in medicine. It bears fruit several months of the year, and it is not unusual to find trees with fruit on one side and blossoms on the other.

Cocoanuts grow all along the seashore, or any spot where nothing else will grow; but they are now very little cultivated. The sapodilla, soursop, pommelo, cherimoya, custard apple, papaw, citron, watermelon, granadilla, pomegranate, and tamarind are some of the desirable exotic fruits that do well in the islands. Vegetables of all descriptions are raised throughout the year, and water and cantaloupe melons are superior to those grown in most countries. Pineapples grow wild on all the islands; there are some twenty-five varieties taking their names from the localities whence they are obtained. Near Pearl City, some eight miles from Honolulu, a plantation of an excellent variety exists. The average weight of the fruits is 8 pounds, although the fruits of some varieties have been known to reach a weight of 17 pounds. The pineapple season is from the middle of the month of May to the middle of August.

Bananas are raised in great quantities and shipped to the west coast of the United States, the cost of cultivation being very small. Along the mountain ranges are trees and vines in luxuriant growth, forests of a magnificent species of tree, whose wood has beautiful markings, and capable of taking a high polish, equaling the finest walnut and mahogany; this is the koa tree. The islands at one time were very rich in sandalwood, but when the natives found it would be a great source of income to them, they cut down the old trees in a very short space of time and sold them to dealers in the United States, and neglected to plant young trees for a future supply.

Not the least important vegetable product is taro. It consists of two kinds—the upland, which grows on the hillsides in dry ground, and the lowland, or more important staple, which is propagated like rice, under water. Long irrigating ditches are required in preparing the bed. The ground is leveled off and inclosed by a wall impervious to water. The floor of the patch is made as rich as possible, and the top is cut from the ripe roots and set out in hillocks placed several feet apart. The water is let in, and allowed to remain until the crop is mature, i. e., in about twelve months, the only labor required being to keep the soil clear of weeds, and provide a depth of about 6 inches of running water. Taro can be planted at any season, and a ripe crop obtained. The root is oblong, the largest being about 1 foot in length, and from 3 to 4 inches in diameter. The root is baked by the natives, who make from it what they call *poi*, the baked root being pounded till it forms a paste, which is thinned by adding water, and afterward allowed to ferment. As a food it is most nutritious.

Another important plant much used by the natives is the ti; it has also a large, oblong root, and the leaves are of a shining green tint. The ti leaves were at one time woven together, and formed a short cloak, which the natives sometimes wore. The root, after baking, is sweet and pleasant to the taste. It is also used to make an intoxicating drink, by bruising the roots with a stone, and steeping in water until it ferments.

Besides the plants mentioned, there are many beautiful flowering and foliage plants, among which codiæums (crotons) are worthy of special mention. All the varieties grow in great luxuriance, and show exceedingly rich leaf coloring.

Round the college grounds, in the suburbs of Honolulu, is a hedge of a night-blooming cereus (Cereus nycticalus), which is a magnificent sight when in flower, the blossoms ranging from 2 to 3 feet in circumference.

* The Gardeners' Chronicle.

SOUND EXPERIMENTS IN A BALLOON.

THE chief object of Mr. Bacon's balloon ascent, which was made from the grounds of the Artillery Barracks, Woolwich, a short time ago, had been suggested by a recent discussion at the Society of Arts. It was the testing of the penetration of certain sound signals as heard from a great distance, and the attempted elucidation of the mystery which enshrouds their behavior under certain circumstances. No conditions more favorable for the observation of sound vagaries can be conceived than are afforded by a balloon flying free in the upper atmosphere.

On this occasion, arrangements had been made by which the penetration of sounds of different kinds could be practically put to the test, and by the kind co-operation of the military authorities, Trinity House, and the Royal Observatory, skilled observers were on the lookout at varying distances from the center of operations. The balloon was under the charge of Mr. Percival Spencer and Mr. Bacon. Unfortunately for the sake of some of the experiments anticipated, a thick haze overspread the sky at a very moderate elevation, and the ballooning party quickly entered the mist, and in five minutes had completely lost sight of the earth. A large portion of East and North London was traversed at a height of from 4,000 to 5,000 feet, but at this elevation nothing was to be seen but dense white clouds piled like the mouth of a huge crater around the balloon.

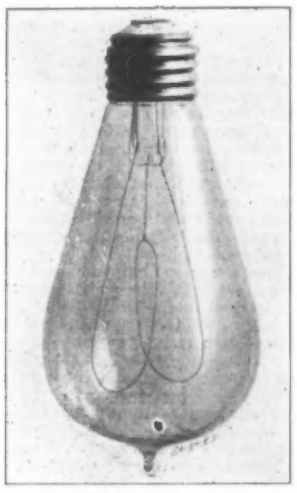
A sharp ear was kept for the sound of the vast city that penetrated upward. Trains were heard in practically continuous rumble, punctuated by their shrill whistles. Sirens from the river and various factories rose sharp and clear. Most noticeable were the barkings of high-voiced dogs, and the raucous yells of street hawkers could be distinctly heard even at a

mile high. The highly instructive fact was noted, however, that, though the city was crossed just at noon, when from the streets the striking of clocks and bells is always such a noticeable feature, yet the most careful listener aloft could detect no sound of this description. The tenor bell at Woolwich Church, which was rung at the time of the ascent, was also wholly inaudible, though a bugle blown from the barrack field was heard a long while after the start. These observations go to prove how inferior are the carrying powers of bells as heard from aloft, and to emphasize the fact that sounds of an unmusical, discordant nature have much better chance of making themselves heard at a distance than have more harmonious noises. Two miles high all sounds of earth were lost save the rattle of trains.

THE INCANDESCENT ELECTRIC LAMP—HOW MANUFACTURED AND TESTED.

By WILLIAM A. DEL MAR, A.C.G.I

ALTHOUGH the incandescent electric lamp was independently developed by Edison, Swan and Maxim, it has reached a state of development where the various makes differ only in detail. It hence follows that a complete description of the manufacturing process employed by one high-class lamp-maker, and a few notes on how other makers vary from this, ought to



THE FINISHED LAMP.

give a fairly thorough idea of how the modern incandescent lamp is made. The following is principally a description of the processes employed by a large European manufacturer.

THE FILAMENT.

Clean, raw cotton is dissolved in hot concentrated zinc chloride solution until the mixture is quite homogeneous and shows no trace of wool. This is done in vats warmed by steam pipes. The mixture is kept hot in this way until it is like thick black molasses. It is then transferred in a ladle to a wide-necked bottle and by means of a siphon is passed through accurate glass die tubes into alcohol or methylated spirit. (Fig. 1.) This siphon consists of a glass tube, bent so as to go to the bottom of the bottle but running horizontally above. A number of

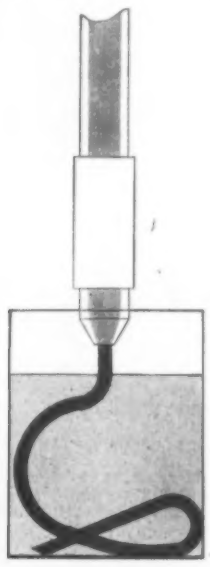


FIG. 2.—DIE TUBE.

vertical tubes are joined to the horizontal one and each of these is attached by a short piece of rubber tubing to a die tube. The die tubes (Fig. 2) are merely short glass tubes drawn out so that their lower aperture is of a diameter that will give a cellulose thread which when shrunken and carbonized will give the correct thickness of filament. This diameter, of course, depends on the voltage and candle power of the lamp and is determined by experience. As the material coming through the die tubes is very light, it falls very slowly in the alcohol and winds in a spiral, as shown in Fig. 2. The stuff that accumulates in the alcohol tanks is a long cord of gelatine-like cellulose. When a jar of it is obtained it is taken out and wound loosely on plush-covered drums, on which it is allowed to dry. As it dries it shrinks very much and cuts deep into the plush and is thus prevented from being unduly stretched.

The filament is now ready for carbonization. It is wound in short lengths on a graphite frame (Fig. 3), and the wound frame packed with powdered coke in a plumbago crucible. This is placed in a furnace and kept at a red heat for a considerable time, after which the crucible and contents are placed in another furnace and kept for a short time at a white heat. If all the carbonizing is done at white heat, the filament will be very brittle. The wound frames are then removed from the crucible and the carbon thread cut off so as to form two filaments of the shape shown in Fig. 4. One side of the frame is detachable so that the filaments are easily slipped off. Before carbonizing, the free ends of the cellulose thread were fastened to the carbon frame by means of a little clay.

The filament is now ready to be mounted. A platinum wire about one inch long and of No. 28 gage is rolled flat at one end in a steel roller press until a surface a quarter inch square is obtained. The flat part is then made into a tube by passing it, screw-fashion, through a number of successively diminishing die holes in a steel plate. The end of the filament is then placed in this tube and secured there by pinching it in with a small pair of pliers. The other end is secured in a similar fashion in another platinum holder. The process of making the tube at the end of the platinum wire is illustrated in Fig. 5, and the filament and holders in Fig. 6.

The next operation the filament undergoes is "flashing." This consists in depositing carbon on it so as to improve the surface and give the filament the right resistance. It is done by heating the filament to a white heat in benzine vapor by passing an alternating current through it. The operation is stopped when the resistance of the filament, cold, has reached a certain value as given by a "Wheatstone's bridge." The arrangement of the apparatus for flashing is shown in Fig. 7. There is a generator of benzine vapor and a bell jar hanging from the ceiling with a counterweight. On the table below the bell jar are a couple of metallic uprights to which the ends of the filament are clamped. These uprights can by means of a double-throw two-pole switch be put in circuit either with an alternating current generator, or in one arm of a Wheatstone bridge which has equal fixed resistances in the other arms. The operator sees no part of the bridge except the galvanometer or current detector. When the filament is in place the bell-jar is lowered over it and filled with benzine vapor. The

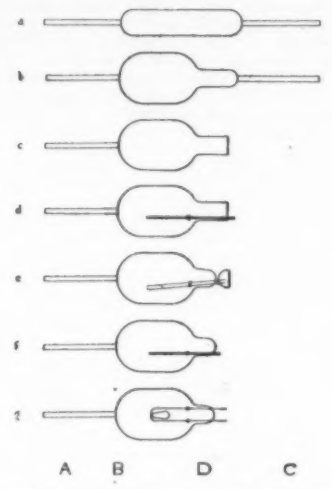
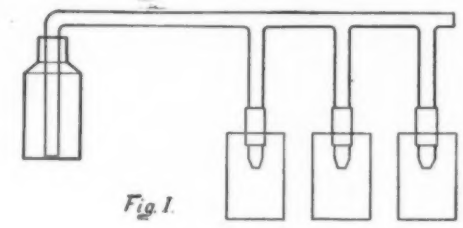
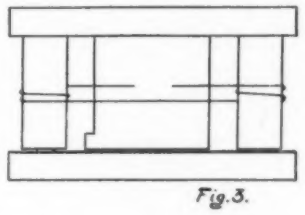
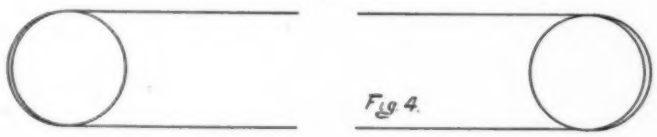


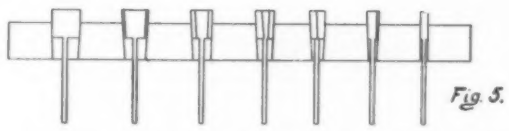
FIG. 9.—EVOLUTION OF A PLAIN BULB.

double-throw switch is then thrown in the alternator circuit and the filament heated to whiteness by the current. The benzine vapor is decomposed and the liberated carbon deposited on the filament which thus becomes thicker and hence a better conductor. This is continued for a few seconds, when the switch is thrown over to the "Bridge" circuit and the galvano-









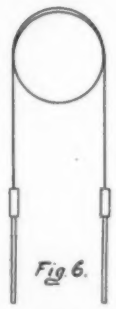


FIG. 1.—THE SIPHON. FIG. 3.—FILAMENT ON GRAPHITE FRAME. FIG. 4.—THE FILAMENT REMOVED FROM THE FRAME. FIG. 5.—MAKING THE PLATINUM TUBE. FIG. 6.—FILAMENT AND HOLDERS.

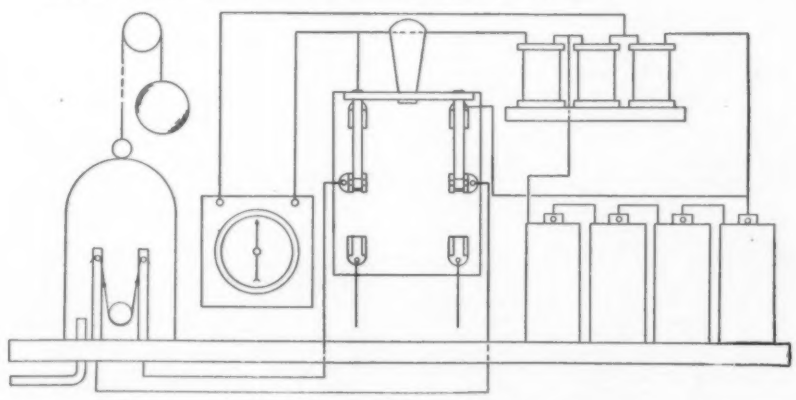


FIG. 7.—FLASHING APPARATUS.

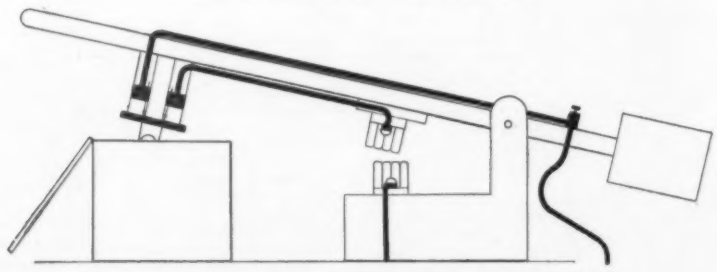


FIG. 8.—DEPOSITING CARBON ON THE FILAMENT.

meter observed. If the needle deflects toward the word "Flash" the switch is thrown over again and the flashing continued until on putting the switch to the bridge circuit the galvanometer needle shows no deflexion at all. This indicates that the resistance of the filament is equal to each of the resistances in the other arms of the bridge. A continuous current cannot be used for flashing, as it would bend the filament out of shape.

The joint between the carbon and platinum not being very good from an electrical point of view, is improved by depositing carbon on it. This is effected

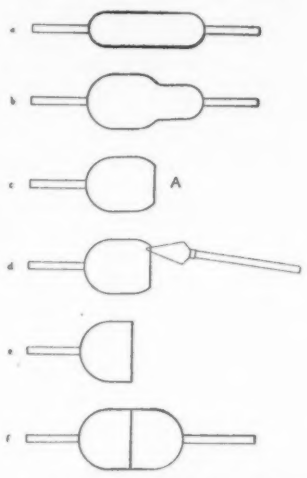


FIG. 10.—EVOLUTION OF A HALF-OPAL BULB.

as follows: The filament is gripped in clamps which hold the two platinum wires and press the filament against a thick bar of copper just above the joint. When the clamps are put in an electrical circuit a current passes through the platinum wires, the joints, and then instead of the high resistance filament it goes through the copper bar. The filament clamp and accessories are on a lever which when pressed down first immerses them in a bath of gasoline and then completes the electrical circuit. The platinum wires on the filament and the copper bar being of low resistance are not heated by the current, but the badly conducting joint gets white hot. The gasoline is decomposed and carbon deposited on the joint. As this fluid is very inflammable, special precautions have to be adopted to prevent or extinguish fires. As already stated, the electrical circuit is not completed until the filament is under the fluid. The gasoline can only

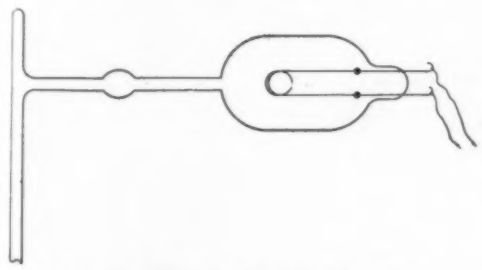


FIG. 11.—EXHAUSTING THE LAMP.

burn at the surface where there is air to combine with it. Hence so long as no spark occurs near the surface there is no danger of fire. The apparatus, which is shown in Fig. 8, is nevertheless provided with a lid which can be instantaneously put on to smother the flames in case of fire. This completes the manufacture of the filament.

THE BULB.

All the lamps are made from a glass tube of the shape shown in Fig. 9 (*a*). In the factory to which this article especially refers these tubes were bought ready made from the glass makers. They are made by blowing glass tubes into molds. One of these tubes is selected and the end, *A*, sealed. The part, *B*, is then brought to a very bright red heat in the blowpipe flame, the tube being continually rotated, by means of the end tubes, between the thumb and forefinger. As soon as this condition is attained, and

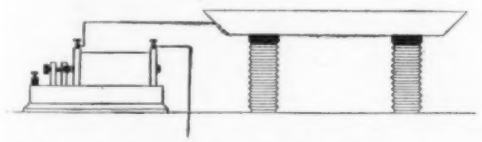


FIG. 12.—APPARATUS FOR TESTING VACUUM.

the heat is uniform all around, the end, *C*, is blown into gently until the tube expands into a bulb at *B*. During the blowing the tube is kept out of the flame, but is continually rotated as while in it. The portion, *D*, is then blown out in a similar way, but to a lesser extent, and the bulb shown in Fig. 9 (*b*) is obtained. In order to be sure that the bulb has the correct diameter it is compared with a ring in which it just ought to fit. The closed end, *A*, is then nipped off near the end by scratching it with a file. The holder tube, *C*, is also cut off and the bulb shown in Fig. 9 (*c*) obtained. The filament is slipped in the hole as shown in Fig. 9 (*d*) and the tube heated strongly all around at *E*. When it is red hot the end, which should not have been made very hot, is seized with a pair of pincers and pulled off as shown in Fig. 9 (*e*). After this the glass is well sealed up as shown in Fig. 9 (*f*), no care being taken about the position of the filament. The whole end is then brought to a very brilliant red heat, the platinum wires seized with a small pair of tweezers, pulled apart, and put in position, and finally the whole taken out of the flame. The lamp then appears as shown in Fig. 9 (*g*).

Fig. 10 shows the various stages in the manufacture of a half-opal glass glow lamp.

The essential process is the widening of the hole,

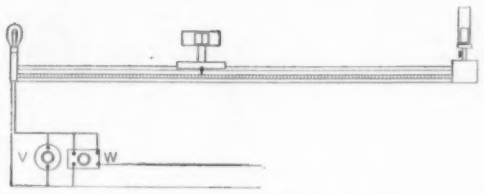


FIG. 13.—TESTING APPARATUS.
V. Voltmeter. W. Wattmeter.

A, Fig. 10 (*c*), by means of the tool shown in Fig. 10 (*d*), until the bulb is cup-shaped as illustrated in Fig. 10 (*e*). This is effected by rapidly rotating the bulb by rolling the holder tube between the thumb and forefinger and pressing the triangular tool against the bright red-hot glass like a tool on a lathe. Two bulbs are made like this, one of clear glass and one of opal glass, and the rims of the two "cups" joined by pressing together at a bright red heat. The opal half is narrowed as shown in Fig. 10 (*b*), and the lamp finished in the same way as the ordinary kind.

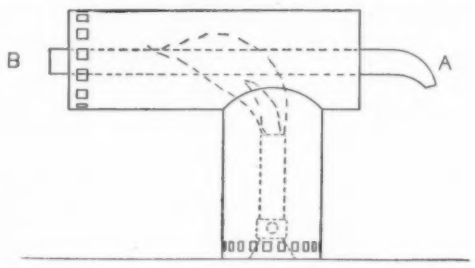


FIG. 14.—SOLDERING APPARATUS.

Whatever kind of lamp is being made, when the filament is fixed in the bulb the long tube is melted on to the glass tube of a mechanical air pump, as shown in Fig. 11, and the bulb exhausted to about 1 millimeter. By changing over a glass cock the bulb is connected to a mercury pump and the exhaustion carried as far as possible. During this latter operation a current much greater than that to be normally carried by the lamp is sent through the filament in

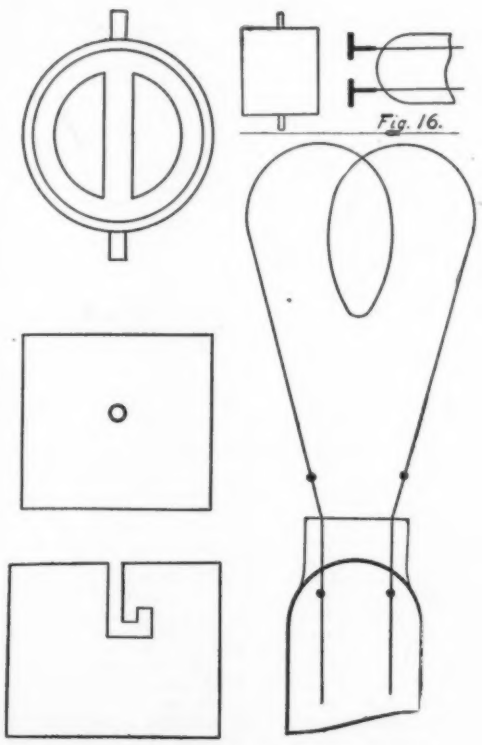


FIG. 16.—BRASS CONTACTS (SHADED). FIG. 17.—PLAN AND ELEVATION OF BAYONET HOLDER. FIG. 18.—FILAMENT AND TUBE.

order to expel any air or moisture that might be in it. While the lamp is thus being heated from within it is covered by a box suspended from the ceiling by pulleys and a Bunsen burner kept burning under it. This helps to get rid of any slight adherent film of moisture on the glass.

THE TESTS.

The lamp is now transferred to the testing room. To start with, the vacuum is tested by touching the metal terminals of the lamp to an iron tray supported on insulators, which is connected to the positive terminal of an induction coil. The negative terminal of the induction coil is earthed and there is a difference of potential of two thousand volts between the tray and earth. If while the glass bulb is held in the hand and the platinum terminals are touching the tray there is any sort of glow in the lamp the vacuum is imperfect. If, on the other hand, no light is visible the vacuum is good. An imperfect lamp is kept at hand to see if the tray is at the proper pressure. This tray is kept in a small dark room with dull black walls.

The lamp is now tested to a high voltage, so that if it has a tendency to break it will do so before it is sent out. It is at this stage that the "Edison effect" is observed. When a voltage somewhat above the normal is applied to the lamp the vacuum appears to have a bluish tint, and if the voltage be quickly increased the filament will break with a loud report. If, however, the lamp be maintained for a few minutes at the voltage first applied the bluish tinge will disappear, and it will bear a great excess of current without being damaged.

The lamp is then tested for candle power and voltage. In testing a lamp three quantities have to be considered, and these are candle power, voltage and efficiency or watts consumed per candle power given out. It is usual for buyers to specify the efficiency as well as the voltage and candle power. The testing is done at "constant efficiency." The life of a lamp is closely related to its efficiency, so that if it is tested by varying the voltage until the efficiency reaches a certain figure all the lamps will have about the same useful life. Suppose an order to be received for a number of lamps for a hundred-volt circuit, which are to have an efficiency of three watts per candle. A box of lamps with filaments designed for one hundred volts is sent to the testing room, and the lamps successively put in circuit with a wattmeter and voltmeter and put on a photometer stand. The voltage is varied by means of a rheostat or variable resistance until the indication of the wattmeter divided by the candle power given by the photometer equals three. The voltage and candle power are marked on the bulb in blue and red temporary marking. All those marked from 98 to 102 are afterward put in holders labeled "100 volts."

THE TERMINALS.

The testing being over, the lamps are taken to a room where a piece of copper wire about one inch long is soldered to each projecting platinum terminal. This is done by means of the soldering apparatus shown in Fig. 14. This consists of a copper bar, *A B*, supported in a horizontal sheet iron drum which stands on a similar but vertical one. The copper bar is kept hot by the flame of a Bunsen gas burner which is in the vertical drum. The apparatus is firmly fixed to the table and the work held up to it. Solder is applied to the clean surface, *A*, until a drop adheres. The ends of the wires to be joined are then put in this globule and drawn away quickly. In this way a very neat joint is effected. In a similar way the brass contacts (Fig. 16) are soldered to the copper wires. Whereas in America only the screw terminal is used, in Europe the bayonet holder shown in Fig. 17 is preferred. There is, however, no difference in the method of putting on the terminals. In the factory this article especially refers to, the bayonet holder is used. After soldering on the two contact brasses a brass ring (Fig. 16) is slipped on and filled with plaster of Paris, care being taken that the plaster does not cover the contact brasses and that neither of the latter touches the outer ring. The lamp is then set aside to dry on a perforated shelf in a warm room. When set and dry the superfluous plaster is removed and the lamp is ready for the final testing. In order to do this it is put in an ordinary "bayonet socket" and the working voltage applied. Its luminosity is compared with that of a standard lamp alongside, and if not found deficient is stamped with voltage and candle power by means of a hydrofluoric acid stamp. The name of the maker is similarly stamped on another part. The lamps are finally wrapped in soft paper and packed in partitioned boxes. All of these processes, except the glass blowing and exhausting, are performed by female labor.

VARIATIONS OF THE PROCESS.

In a well-known American lamp the platinum wires attached to the filament are soldered to the copper wires before they are fused in the glass. The filament and its attached wires are fused and pinched into a short glass tube, as shown in Fig. 18, and this tube fused into the bulb as shown in Fig. 19. This effects a considerable saving in platinum wire—a very important item in the cost of a lamp.

Some makers blow their bulbs into a mold so as to assure all of them being of the same size. In some factories the usual method of exhaustion is supplemented with a chemical process which produces a very perfect vacuum.

In the screw holder one terminal of the filament is soldered to the inside of the screw ring and the other to a central brass contact. There is thus one piece of brass less in the American than in the European lamp.

Some lamps such as that shown in Fig. 19 have the middle of the filament secured to the glass by a piece of wire which forms no part of the electrical circuit.

It has been found that an increase of efficiency can be obtained by adding a little finely divided silica to the cellulose solution of which the filament is made.

There are many other points which might be mentioned, but the foregoing description should give a fair idea of how an incandescent electric lamp is made.

INDUSTRIAL TRIUMPHS OF ELECTRO-CHEMISTRY.*

By SAMUEL SHELDON.

INTRODUCTION.—In this paper an attempt is made to give a general view of the present condition of the electro-chemical industries. The subject of storage and primary batteries is so large and is so clearly differentiated from the other electro-chemical industries that it is not touched upon. The subject of electrotyping is also not considered. The carrying on of the other industries requires over 200,000 horse power. Of this about 90 per cent is obtained from water power. The cost of electrical power, obtained from water power, varies much in different parts of the world. Swan gives the limits per horse power year as $5 and $50. At Niagara the price to large consumers is about $17. This power is delivered in Buffalo for about $30.

Critical Current Density.—In the electro-deposition of metals from a salt solution the rate of deposition which may be used is limited. If a proper current density at the cathode be employed, an adherent reguline deposit will result. If the current density be increased, a limit is reached, when, if exceeded, the character of the deposit will change, becoming pulverulent and non-adherent. This limit is termed the *critical current density*. As an increase of the permissible current density allows of a smaller plant for the same output and shortens the time that the metal in the solution is idle, a consideration of the factors, which determine the value of the critical current density, is pertinent. Consider a cubic centimeter of metallic salt solution at rest, and directly in front of a cathode. It contains a certain weight of the metal. This weight is dependent on the concentration of the solution and can be calculated from its specific gravity. A certain percentage of this metal, dependent on the temperature and concentration of the solution, is dissociated and takes part in the electrolytic conduction. If an attempt be made to so adjust the current, flowing through this cubic centimeter, that by Faraday's laws the rate of deposition is such that all the dissociated metal ions must be deposited in one second, then, it is evident, the velocity of movement or migration of the ions would be one centimeter per second. Such a rate of deposition of ordinary metals from a stationary solution is impossible. The maximum velocity of migration is rather to be reckoned in thousandths of a centimeter per second. If the deposit is to remain reguline, the ions must not be expected to migrate faster. It is possible, however, to adjust the circuit for any current density. As soon as the rate of deposit exceeds the ability of the metal ions to supply it, hydrogen of the solvent appears to take part in the conduction and a pulverulent deposit results, which contains some hydrogen and is said by some to be a hydride of the metal. The critical current density can be increased by increasing the concentration of the solution, by raising its temperature, or by *circulating the electrolyte toward the cathode.*

Circulation.—Circulation of the electrolyte has three functions. It permits of a higher rate of deposition, as mentioned above; it replenishes the part of the electrolyte next to the cathode which has been deprived of its metal; and it prevents, to a certain extent, the deposit from assuming a nodular or aborescent form. When deposition is taking place at moderately large current densities, accidental differences of concentration occur in the vicinity of the cathode. Places on the cathode which can be reached by current flowing through the more concentrated portions of the electrolyte will receive a heavier deposit than other places. As a result, they will protrude slightly from the cathode. These unevennesses are multiplied and magnified as the deposition continues.

Dissociants.—The water of an ordinary electrolyte performs two duties. First, it acts as a solvent, whereby it allows and facilitates the uniform distribution of the dissolved substance throughout the solution, subdivision of the substance being carried to a condition of a molecular fineness. Secondly, it acts as a dissociant whereby some of the molecules of the dissolved substances are split up and dissociated into their component ions. Without dissociation there can be no electrolytic conduction of the current. Besides water the following substances are common solvents and dissociants: liquid ammonia, ethyl alcohol, methyl alcohol, glacial acetic acid, and pyridin. The last named contains no oxygen, and it has been recently shown by Dr. Kahlenberg that from a solution of lithium chloride in it, pure metallic lithium may be electrolytically deposited.

Copper Refining.—Refined copper constitutes the most valuable product of all the electro-chemical industries. The processes of producing the refined copper from its alloys have been well described by Badt. The copper alloy or blister copper is cast into slabs which are used as anodes in a bath containing a slightly acidulated solution of copper sulphate. This electrolyte is kept in continuous circulation. Pure copper is deposited from the solution upon pure copper cathodes at a current density of from 15 to 25 amperes per square yard. Copper is simultaneously dissolved at the anode, and the alloyed gold, silver, and other metals drop, as a slime, to the bottom of the cell to be parted and recovered later. After deposition the cathodes are melted up, poled, and cast into wire-bars or other suitable forms. The "poling" of copper consists in stirring the molten metal with a pine stick. The stick carbonizes, and, as a result, reduces cuprous oxide which is present in the molten copper. Upon cooling, cuprous oxide gives up its oxygen to metallic impurities which may be present in the copper. As the mechanical and electrical properties of copper are better when impurities exist in the form of oxides rather than as metals, the proper amount of poling is when just sufficient cuprous oxide is left to oxidize the impurities. Overpoled or underpoled copper is brittle and of inferior conductivity. Polytechnic Institute of Brooklyn, February, 1902.

Parting of Gold and Silver.—This is accomplished by means of electrolysis very satisfactorily in the following manner. The alloy of the two metals constitutes the anode, and is placed in a linen bag. The cathode is a thin sheet of pure silver. The electrolyte is at first a one-tenth per cent solution of nitric acid, which ultimately becomes a dilute solution of silver nitrate. With a current density of 33 amperes per square foot, silver 999.5 per mil fine is deposited on the cathode in the form of beautiful crystals. These are mechanically scraped off and allowed to drop to the bottom of the cell. Gold, in the form of mud, containing some silver, collects in the anode bags. The silver is removed from it by dissolving in nitric acid, leaving the gold in a very pure condition.

Extraction of Gold.—The process of Siemens and Halske, which is in use in South Africa, consists in dissolving the gold from the crushed ore in solution of cyanide of potash and then subjecting the solution to electrolysis with iron anodes and thin sheet lead cathodes. The anodes are dissolved. Dr. Keith improves upon this process by adding a small amount of soluble mercury salt to the cyanide solution. It increases the rapidity of solution, and mercury is deposited alongside of the gold on amalgamated copper cathode plates. The amalgam is scraped from these plates and the gold and mercury separated by "retorting."

Extraction of Gold.—The process of Siemens & nickel ores are first roasted, crushed, and leached in a mixed solution of cuprous chloride and calcium chloride. By electrolysis with carbon electrodes the copper is removed from the solution. The lead and iron are removed by chemical means. There then remains a solution of nickel chloride. This is electrolyzed, and the nickel deposited upon a nickel cathode.

INORGANIC PRODUCTS.

Alkalies and Bleach.—The power employed in the electrolytic preparation of these substances amounts to more than 50,000 horse power. There are many different processes employed, some of which are secret. The electrolyte is always common salt, either in water solution or in a fused condition. Upon passage of a current, using a carbon anode, chlorine is developed in the gaseous form at the anode and is led to chambers containing lime with which it forms bleaching powder. Metallic sodium appears at the cathode. If the cathode be mercury, as in the Castner process, a sodium amalgam is formed, which, upon washing with water, yields caustic soda and returns the mercury. If the cathode be iron, in a water solution, caustic soda is developed by secondary reaction. In the Acker process the electrolyte is fused salt and the cathode is molten lead.

Sodium.—This is manufactured on a commercial scale at Niagara by the electrolysis of fused caustic soda. The electrolyte is maintained in a fused condition by the current which passes through it. An iron containing vessel constitutes the cathode and the anode consists of rods which dip into the electrolyte. The sodium after deposition rises to the top of the electrolyte, and floats upon its surface. As it accumulates it is removed by small iron dippers. The sodium, after its reduction, is used in the manufacture of sodium dioxide. This is done by spreading the metallic sodium on trays, which are placed in tubes, that are supplied with air, dried over calcium chloride. The sodium peroxide is then used for producing peroxide of hydrogen. For this purpose it is mixed with sulphuric acid, and during the mixture the temperature is maintained near zero by melting ice. This is necessary because of the unstable character of the peroxide of hydrogen.

Aluminium.—This metal is reduced electrically from alumina by the Pittsburg Reduction Company at Niagara Falls, in America, and at Shawinigan Falls, in Canada, and by six other firms in Europe. The annual product in America is about 3,000 tons. Kershaw estimates the total output for 1901 as 7,500 tons. The double fluoride of aluminium and calcium, in a fused state, is used as a solvent and dissociant. The heat developed by the passage of the electrolyzing current maintains the solvent in a fused state. The electrolyte is contained in large cavities made in carbon slabs. The carbon constitutes the cathode and groups of large carbon rods, dipping into the fused electrolyte, constitute the anodes. The metal is drawn off once a day through taps leading to the bottom of the cavities. As the electrolyte is deprived of its metal its resistance rises. This fact is utilized to give warning to attendants. An incandescent lamp is shunted between the electrodes, and, as the resistance of the electrolyte rises, the brilliancy with which the lamp burns increases. The attendant then introduces fresh alumina to the fused electrolyte. The process is thus continuous and uninterrupted.

Sponge Lead.—This is produced from litharge by placing it in contact with a sheet lead cathode in an electrolytic cell having a lead anode and dilute sulphuric acid as the electrolyte. The deposited hydrogen reduces the litharge, leaving a lead sponge of fine quality. This process is employed by the National Battery Company at Buffalo. The Electric Lead Reduction Company of Niagara Falls is also producing sponge lead by subjecting galena to electrolysis.

Potassium Chlorate.—This is manufactured in considerable quantities by the National Electrolytic Company at Niagara Falls by the electrolysis of a solution of potassium chloride. The process is not ideal as compared with many other electrolytic processes, and the yield is not as great as could be desired for the electrical energy which is employed. The yield is increased by introducing a small quantity of potassium chromate into the electrolyte as shown by Muller, and the introduction of a little alumina neutralizes the potassium hydrate as it forms at the cathode. The cathodes, as used at Niagara, are of wire gauze covered with cuprous or cupric oxide. The reduction of the oxides by the liberated hydrogen develops sufficient heat to maintain the temperature of the electrolyte at 50 deg. C. The electrolyzed solution is led into refrigerating tanks, where the chlorate is made to crystallize by lowering its temperature.

Ozone.—This gas is a modified form of oxygen. It is generally stated that a molecule of ozone contains three atoms of oxygen, while a molecule of gaseous oxygen contains but two atoms. This, however, is uncertain. Ozone differs from ordinary oxygen in being a much more powerful oxidizer at ordinary temperatures. It very quickly oxidizes organic substances. Ordinary rubber becomes brittle and crumbles after an immersion for a short time in the gas.

There are many forms of apparatus devised for the electrolytic production of ozone. The general principle underlying the construction of all of them is to pass a stream of dry oxygen or air between two conducting surfaces which are close to each other. The conductors are subjected to differences of potential which are rapidly varied in amount over wide limits. The high tensions of electrostatic machines, induction coils, or transformers are used. Disruptive discharges may be employed for producing the rapid change of potential difference. One company is using an alternator which gives 10,000 cycles per second. The issuing gas is said to be ozonized. At best it contains but little above one per cent of ozone. A molecule of oxygen, consisting of two atoms, each bearing an electric charge, when subjected to the sudden variations in the electrostatic field between the conductors, may in some, or many cases, be torn apart. The constituent parts may join with other molecules of oxygen to form ozone molecules.

Ozone is used on a commercial scale in yielding organic oxidation products, in sterilizing water for potable purposes, and in bleaching fabrics. Among its proposed uses may be mentioned the decoloration and defecation of sirup in sugar manufactories, the ageing of wines, and the ageing of woods for the construction of such musical instruments as violins.

Nitric Acid.—One firm, which is interested in electro-chemistry, has perfected a method for the electrolytic production of nitric acid, the nitrogen being recovered from the atmosphere. The electrical process very materially reduces the cost of production. The importance of such a process may be very great in the future. Nitrogen is essential in the diet of all the higher forms of animal life. Soils are deprived of their nitrates by the crops which are grown. The supply is replenished to some extent by parasites which grow in nodules on the roots of leguminous plants. These parasites are capable of taking nitrogen from the atmosphere and oxidizing it. And yet fertilizers containing nitrates have to be applied to the soils to maintain their productiveness.

ORGANIC PRODUCTS.

Several hundred organic substances have been prepared in the laboratory by means of electrolysis. Most of them remain as laboratory preparations, but some have come upon the market, being manufactured on a commercial scale. All these organic products may be arranged in four classes depending upon the ultimate constitution of the substance yielded as compared with the composition previous to electrolysis. Without considering the actual electrolytic process, the effective process is either one of oxidation, of reduction, of concentration, or of substitution or addition. These processes, like all electrical processes, are especially valuable because of the extreme delicacy of regulation which is possible. The efficiency of the process as regards yield is thereby increased.

Electrolytic methods constitute a valuable addition to the facilities at the disposal of the organic chemist. In carrying on experimental work, attention should always be given to the temperature, to the concentration, and to the current density which is being employed.

Iodoform.—This is prepared by the electrolysis of ethyl alcohol in a solution of sodium or potassium iodide. The anode is of platinum and is placed in a solution of 15 parts of potassium iodide, 100 parts water, and 16 parts of ethyl alcohol. This solution is separated by a porous diaphragm from a strong solution of sodium hydroxide, which contains a nickel cathode. The temperature of the electrolyte is kept at 70 degrees C. and a current density of one ampere per square decimeter is employed. After passage of the current for three or four hours, the solution is allowed to cool and iodoform crystallizes out.

Chloroform and Bromoform.—It is claimed that by substituting chlorides or bromides for the iodides in the above process either of these two substances may be prepared.

Camphor.—If turpentine hydrochloride, in a melted condition, or in an alcoholic acetic acid solution, be electrolyzed, camphor is obtained. Camphor results from the oxidation of terbene, i. e., oil of turpentine. Artificial camphor is made from turpentine in large quantities by the Ampere Electro-Chemical Company, but the process is claimed to be in nowise electrical.

Vanilin.—This substance, which is the odoriferous component of vanila, is obtained by the oxidation of eugenol (oil of cloves). It is much used in the manufacture of perfumes. It is produced electrically on a commercial scale in France.

Artificial Rubber.—A process for the electrical production of artificial rubber is being experimented with, and it is said to promise much for the future. No details concerning the method are being given to the public.

FURNACE PRODUCTS.

The electric furnace owes its great utility to the facility with which its temperature can be regulated, and especially to the great elevation of temperature which is obtainable. The amount of heat which is produced in a conductor is dependent upon the resistance of the conductor, the strength of the current, and the duration of the flow. All of these are easily altered in magnitude. The temperature of the conductor is determined by the rate of development of heat and upon the facility which is offered for its escape. The ultimate stationary temperature is attained when the rate of escape of heat is equal to the rate of its production. With a given rate of heat production the temperature rises as the facility for the escape of heat is lessened. The many available heat insulators make it possible to produce any temperature which can be withstood by the conductors.

Calcium Carbide.—This substance, which is prepared by heating a mixture of coke and lime in an electric furnace, constitutes, at present, the most valuable electro-chemical product, with the exception of copper. Furthermore, its production requires more power than any other electro-chemical industry. Ker-

* Stationary Engineer and Machinist.

shaw estimates that in 1900 the power employed was 85,000 horse power. The rate of production has been in excess of the rate of consumption and the result has been a decrease in the price of the product.

Its value lies in the fact that, when placed in water, acetylene gas is developed to the extent of about five cubic feet per pound of carbide. When burned in air, the acetylene gives a flame of great intrinsic brilliancy and of pleasing color quality. Its richness in carbon tends toward a sooty flame. Swan inclines to the belief that the gas may prove of great value in metallurgy as a reducing and carbon-carrying agent.

Calcium carbide is put in the class with explosives and dangerous chemicals. It is, therefore, subject to high freight rates for transportation, and is associated with high insurance rates. Owing to the moisture ever present in the atmosphere it suffers from freight transportation over long distances. These facts militate somewhat against its adoption as a source of illumination for small towns.

Carborundum.—This substance is carbide of silicon. It is an abradant, harder than emery, and is used for the same purposes as the latter. It is made into wheels, into tools of various forms, and into hones. The process of manufacture consists in heating electrically to a very high temperature, a mixture consisting of 60 per cent pure sand and 40 per cent powdered coke. To this mixture is added a small amount of common salt, and sufficient sawdust to render the mass porous, so that gases, which are liberated in large quantities, may escape. This mixture is packed around a "core" of coarse granulated coke, the grains having diameters of from ⅛ inch to ⅜ inch. An alternating current is sent through the core and produces heat, which does not easily escape through the surrounding mixture. The result is a great temperature elevation and the formation of the carbide, some of it being in the form of very beautiful violet-colored crystals.

Artificial Graphite.—Upon the common introduction of arc lighting, it was noticed by many observers that the tips of remnant carbons were transformed into something resembling graphite. The transformation extended only over the portions of the tips which had been heated, in the lamp, to a high temperature. In the manufacture of carborundum, it was observed that there was always produced a layer of graphite in the hottest part of the furnace. Upon investigation the conclusion was reached that graphite was not formed by merely heating pure carbon to a high temperature, but that a carbide must be first formed and afterward be decomposed by the electric furnace heat. Therefore it is necessary to have some metallic salt or oxide mixed with the carbon before heating. In practice, a good mixture consists of 97 parts of finely divided amorphous carbon commingled with three parts of iron oxide. This mixture permits of molding into any desired shape which is afterward graphitized. The molded articles are placed inside of a hollow carbon cylinder of about 20 feet in length and 20 inches in diameter. Current is sent through the cylinder in a longitudinal direction. As the articles become graphitized they acquire a greater conductivity, and the current which flows under a given impressed voltage increases accordingly. In practice the original impressed voltage is about 150 and the amperage about 300. As the graphitization proceeds the voltage is decreased, although the amperage increases.

Barium Hydrate.—The United Barium Company is manufacturing about 60 tons per day of this substance at Niagara. It is in the form of large crystals of an inch or more length on the edge. The manufacture by the electrical method has reduced the price of the product to one-quarter what it previously was. It is consumed in large quantities in the manufacture of pigments, in the purification of water, and in the recovery of sugar from beet molasses. In the last case a ton of hydrate is consumed in the recovery of a ton of sugar. The hydrate is made from crude barytes, this being the only natural source of barium. One equivalent of barytes is mixed with three of barium sulphate, and the mixture is heated in an electric furnace. SO_2 is driven off in the form of vapor, leaving barium oxide behind. This oxide, upon being placed in water, becomes hydrated. It is then allowed to crystallize.

Barium Cyanide.—This is manufactured by the Cyanide Company, at Niagara. It is used in the production of the other cyanides. Barium carbide, a substance, which is the analogue of calcium carbide, is mixed with coke and producer gas is passed through the mixture while it is being heated electrically. The carbide has an unsaturated molecule, and the three free bonds of each carbon atom easily take an atom of nitrogen.

Phosphorus.—This is manufactured by the Oldbury Electro-Chemical Company. The electrical process is practically the same as the chemical process, except as to the method of applying heat. Calcium phosphate, either in the form of bones or of natural rock phosphate, is pulverized, mixed with coke, and placed in an electric furnace. Upon passing current through the mixture, the phosphorus becomes vaporized and is collected under water. The electrical process is cheaper than the older chemical one. This is because of two reasons: The temperature necessary to vaporize the phosphorus is quite high. There is, therefore, a large loss of heat when it is applied to the outside of the closed retorts containing the phosphate. This loss is not present when the heat is produced electrically inside of the retort. Again, the practice of the older process was attended with much breakage of retorts, which is absent in the case of the newer.

Corundum.—The Norton Emery Wheel Company is manufacturing five tons per day of this artificial emery, which differs from the natural emery in being absolutely pure and of uniform specific gravity. The natural variety lacks these two qualities, which are essential in the manufacture of a perfectly satisfactory emery wheel. The process of production consists simply in the heating of bauxite in the electrical furnace until water is driven off and the remaining alumina becomes molten. Upon cooling this latter assumes a crystalline form.

Iron and Steel.—There are a number of experimental plants in various parts of the world manufacturing steel directly from iron ores by means of the electric furnace. None of them have, however, passed the experimental stage. A number of alloys of iron, which are found useful and valuable in the manufacture of steel, are made in considerable quantities by means of the electric furnace. Among these may be mentioned ferro-chromium, ferro-titanium, and ferro-silicon. The first was used in the manufacture of armor plates intended for the cruiser made in this country for the Russian government.

Silicides.—A very interesting line of substances has been produced by the Ampere Electro-Chemical Company, by means of the electric furnace, which it has termed *silicides*. They are the analogues of the carbides. Especially interesting is silicide of barium, which decomposes when placed in water with a development of hydrogen gas.

MISCELLANEOUS.

Electrolytic Condensers.—If two carbon electrodes in a solution of zinc sulphate have impressed upon them a small difference of potential, a current will flow until the counter electro-motive force of polarization, resulting from the deposition of zinc on the cathode, is equal to and opposes the impressed e. m. f. Upon removing this latter e. m. f. without opening the circuit, an inverse current will flow until the zinc has been redissolved. Such a combination constitutes an electrolytic condenser, its charge being the quantity of electricity associated with the deposited zinc. Its capacity is this quantity divided by the polarization e. m. f. produced by it. This capacity is very large and increases with the area of the submerged portions of the cathode. Such condensers cannot be utilized with potential differences in excess of the maximum polarization e. m. f. They are also very inefficient, due to leakage currents necessary to compensate for local action. For use with higher voltages cells may be used in series. For the same volt-ampere capacity electrolytic condensers occupy about the same space as ordinary condensers of paraffined paper and tin foil. They have all the disadvantages associated with liquids.

The Electrolytic Rectifier.—This device in its latest form, as designed by Pollak, consists of an electrolytic cell containing a slightly acid solution of potassium phosphate as an electrolyte. One electrode is of plain lead and the other is of aluminium, which has been formed by macerating it for some time in a solution of caustic soda. If the pressure on a circuit, in which this cell is connected, does not exceed 200 volts, and the temperature of the electrolyte be under 40 deg. C., then the cell will allow current to pass through it from lead to aluminium, but not in a reverse direction. This action is due to the formation of an insulating skin of aluminium hydrate over the surface of the aluminium when it is functionating as an anode. By means of such a cell one lobe of an alternating current cycle can be extinguished. The life of a formed aluminium plate is about 500 hours. The skin then breaks down and separates from the plate.

Electrolytic Interrupters.—The Wehnelt interrupter consists of an electrolytic cell with dilute sulphuric acid as an electrolyte, with a plain sheet lead cathode and with an anode of platinum wire, exposing a small surface (say ¼ sq. cm.). The Caldwell interrupter consists of a cell, with almost any electrolyte, with both electrodes of carbon, lead, or other suitable material, the cathode with its surrounding electrolyte being separated from the anode and its surrounding electrolyte by an insulating diaphragm containing one or more minute perforations. Upon introducing either of these interrupters into circuit a series of sudden interruptions of the current will occur. These are due to the evolution of non-conducting gases around the platinum wire in the one case and in the diaphragm perforations in the other case. After interruption the circuit closes again as soon as the gases arise, due to their buoyancy. The frequency of interruption can be easily regulated. It increases with increase of impressed voltage, with decrease of inductance and resistance in the circuit, with decrease of exposed anode surface, and with increase of hydrostatic pressure at the place of interrupting gas development. When properly designed and used in the primary circuits of induction coils, these interrupters produce remarkable results. The suddenness with which the magnetic flux, which is linked with the secondary, can be made to disappear, is responsible for the high e. m. f. developed. The great amount of energy localized at the point of interruption of the circuit is destructive to the surrounding insulation. Lava is employed with considerable success.

LONDON'S LATEST CENSUS.

THE figures given by the "Detailed Abstract of the 1901 Census Returns for the County of London," apply exclusively to the Administrative County of London, and the persons actually within that sphere on the night of the census. London, as every one must be aware, is a name of peculiar elasticity. If we take it, for instance, to mean the municipal city of London—the "one square mile"—we find that its stationary population is only 26,923 souls. And if, on the other hand, we take it to imply so-called "Greater London," which embraces over 400,000 acres and includes such distant suburbs as Epsom, Farnborough, Barnet, and Waltham Abbey, Londoners may then boast the mighty population of over six and a half millions (6,581,372). Actually, however, we are concerned with London County proper, created in 1888 from parts of Middlesex, Surrey and Kent, and having an area of nearly 75,000 acres. The total population of London, in this meaning, is 4,536,541. In 1801 the population was just under one million (959,310); it has therefore increased during the century nearly five-fold, but since 1851 a decline in the rate has been in steady progress. One of the most potent causes influencing this decrease in the rate of growth of population within the county area is the migration of Londoners to the suburban districts. During the last ten years the loss by migration is calculated as exceeding 180,000. This centrifugal dispersion of town population is, however, shared by all great, old and prosperous cities.

In an ecclesiastical way, London County is of four dioceses or parts. The diocese of London has 2,786,585 parishioners; that of Rochester contained in the county, roughly, 1,000,000 less; that of St. Alban's, only 3,086; while the diocese of Canterbury, represented exclusively by Lambeth Palace, returned but thirty-seven persons. The population of some of the civil parishes in the county was in some cases similarly diminutive. In the city parish of St. John the Evangelist, for instance, only two persons were enumerated. Against this ridiculous total may be set the figures of Islington, having a population of 334,991 or of Lambeth, with 301,895.

The number of families in the metropolis is returned as just over one million (1,019,546), giving an average of rather more than 4.4 persons to a family.

There are 571,768 houses in London, 40,069 uninhabited houses and a rough 5,000 now in process of building. All inhabitants are, however, not so fortunate as to be sheltered under their hospitable roofs, for a total of 406 persons—224 males and 182 females—were enumerated as having passed the night of the census in barns, sheds, caravans or similar places. At the same time, each of the million families in London has some holding or tenement. As regard the latter, the rate of increase in tenements of five rooms and over was exactly double that shown in tenements of less than five rooms. Single-room tenements declined from 172,502 in 1891 to 149,524, and the number of one-roomed tenements with six or more inmates declined from 4,097 ten years ago to 1,802. So that in all the aspect of overcrowded London begins to look a little brighter.

The females in London, it may be remarked, exceed the males by a quarter of a million (252,371). The number of children of school age (3 and under 14 years) reaches to close upon 1,000,000 (968,007).

London is above all things a busy city, and in support of this we may note that in 1901 the percentage of the total population aged 10 years and upward engaged in occupations, was, in the case of men 83.6 and in the case of women 37.4. With regard to the occupations followed by men, one of the greatest increases is that classified under the heading of electrical apparatus makers and electric supply—one, namely, of 166 per cent. Another most notable increase was in the numbers adorning the overcrowded profession of acting. There are now 2,234 actors in London—an increase of 75 per cent over the figures returned in 1891. Of literary people in general, including authors, journalists and editors, there are 3,446—this showing an increase of 24 per cent in the last ten years. To clothe London requires over 35,000 male tailors, the same number of female workers, and an additional 105,678 women classified as dressmakers, staymakers, milliners, etc. This, however, does not include makers and dealers of "foot gear" nor does it include the 2,000 odd artificial flower makers—a profession that has declined in favor by 41 per cent during the past decade. The women occupied as commercial or business clerks have increased in number since the 1891 census to the alarming extent of 181 per cent. They now number 19,097, as against the 84,317 males occupied in this prosaic pursuit.

The Londoners proper, native in the county, were returned as just over three millions strong (3,016,580). Others living in the metropolis included 60,211 Irishmen, 56,605 Scotchmen, 35,421 Welshmen, and 161,222 persons of foreign birth. Of the 135,377 foreigners not naturalized British subjects, natives of Russia are now the most numerous in London; Germany stands second, Russian Poland follows, France is fourth and Italy fifth. The Russians in London have increased since the last census from 12,034 to 38,117—fully threefold, that is—while Italy has doubled her contribution toward the population, now accounting for a round 10,000.

The American invasion takes the form of—actors! No less than three-fifths of the foreigners returned under this profession—most unkindly referred to by the census as a "minor occupation"—were natives of the United States. The musicians from Germany, however, outnumber the actors and actresses from the States, the figures being 300 German bandsmen, against 211 actors with a twang.

NEW RAILROADS IN SWITZERLAND.

THE Bulletin of the Société des Ingenieurs Civils contains an account of the new railroad lines which are being built in Switzerland. The government has allotted the sum of $1,600,000 for the construction of two railroads, one from Reichenau to Ilanz, and the other from Thusis to Saint-Moritz. The latter is of interest on account of its profile and the difficulties which had to be overcome in its construction. The Thusis-Saint-Moritz road is 39.1 miles long; its starting point is at 2,300 feet altitude, and its terminus at 5,790 feet, but the culminating point is in the middle of the Albula Tunnel, or 5,925 feet. The starting point is on the river Albula, a tributary of the lower Rhine, and the terminus is on the Inn, an affluent of the Danube. The line traverses the Col de l'Albula by a tunnel of considerable size. On the southern side the profile of the road is easy, but on the north, in the Rhine region, it was necessary to resort to a number of artifices to give the line the required development, and this in spite of the heavy grades adopted, the maximum of which reaches 35 per cent, while curves as low as 300 feet radius are used. Between Thusis and Saint-Moritz there are 10 miles in tunnels or 26 per cent of the whole, and 1.7 miles in viaducts. The road is narrow gage (39 inches) and single track. It is between Thusis and Tiefenkasten, a distance of 7.6 miles, that the most difficult part of the road begins. This section has 33 per cent in tunnels and 15 per cent in viaducts; of the latter the only metallic construction is a bridge over the Rhine at Thusis of 260 feet span. Here the grades do not exceed 25 per cent, and the cost of the section is about $88,000 per mile. The Tiefenkasten-Filisur section starts at 2,890 feet altitude and ends at 3,519 feet, being 6.4 miles long. It has two important viaducts, that of Schmittentobel, 450 feet long and 116 high, with 7 masonry arches, being built in a curve of 450 feet radius and a 25 per cent grade, and the Landwasser viaduct, 705 feet long, with 5 arches, on a 20 per cent grade and in part on 330 feet radius. After this comes a tunnel of 690 feet,

which ends at the station of Filisur. From this point commence a series of 35 per cent grades, reduced to 30 in the tunnels. As far as Bergün, a distance of 6.8 miles and a difference of altitude of 949 feet, it has been necessary to obtain an artificial development of 4,000 feet by means of detours, including a number of tunnels whose combined length is 20 per cent of the section, and 8 viaducts representing 1,000 feet. The cost is here $73,600 per mile.

From Bergün to the Albula Tunnel the distance is 7.4 miles. The most difficult part is between Bergün and Preda, which is at the north entry of the tunnel at 5,820 feet altitude. It was necessary to give an artificial development of 3.3 miles, and this is accomplished by a number of curves and spiral tunnels, some of which are superposed in the most extraordinary manner. In this way the road has a total length of 7½ miles, while the absolute distance between the terminals is less than 4 miles. This portion has 24 per cent in tunnels and 5 bridges from 70 to 130 feet in length. The cost is $73,600 per mile. One of the main pieces of engineering work is the Albula Tunnel, which will be 3.5 miles long. It lies between the stations of Preda and Spinas; toward the former side it has a 10 per cent grade up to the middle, then it descends in a 20 per cent grade. Its height is 16 feet and width 14 feet. Most of the tunnel passes through compact granite which is extremely hard. The work was begun on the north end on the 15th of October, 1898, and on the south end a few weeks later, using Brandt drills. It is estimated that the tunnel will cost $1,140,000, or $32,000 per mile. The total cost of the railroad will be $4,400,000, including the tunnel.

The second line, from Reichenau to Ilanz, does not present the same difficulties of profile as the former. It follows the upper Rhine valley and crosses this river three times upon metallic bridges. The road has a number of tunnels whose total length is 2,600 feet. Its estimated cost is $660,000 or $39,000 per mile. As to the former line, the Thusis-Saint-Moritz, it is expected that it will be opened in the spring of 1903. The road will be much appreciated by tourists and frequenters of the watering-places, who are now transported by the Federal posts between these two localities in 10 or 11 hours. By rail it is expected to make the trip in 2½ or 3 hours. The Albula tunnel is now being pierced on both sides, and it is hoped to finish the work in June of the present year. The number of workmen employed on the outside and in the interior of the tunnel is 622 on the north side and 243 on the south, or 895 in all.

LOSS OF LIFE IN THE UNITED STATES BY LIGHTNING.

ABOUT a dozen years ago it was a commonly expressed opinion that more lives were lost by lightning than by violent winds and tornadoes. In order to determine as accurately as possible the number of fatalities from each of these causes, a statistical inquiry was set on foot in 1890 by the Weather Bureau, which inquiry has been maintained, so far as lightning is concerned, up to and including the calendar year 1900.

As a result of this inquiry, extending over eleven years, it is found that the greatest number of fatalities occur in rural districts, some distance from telegraph and telephone lines, and from the great news centers. The death of the victim is generally chronicled in the county paper, but rarely in press dispatches and the larger dailies. For that reason the task of the bureau has been particularly difficult. In the older and more densely populated Middle Atlantic districts the information at hand is much more complete; yet, after all, it is only when every county paper in the land has been carefully scanned, that the Weather Bureau will feel perfectly sure that its results are approximately correct.

During 1900 seven hundred and thirteen persons were killed or received fatal injury. Of this number 291 persons were killed in the open, 158 in houses, 57 under trees, and 56 in barns. The circumstances attending the death of the remaining 151 are not known. Nine hundred and seventy-three persons were more or less injured by lightning stroke during the year. Of this number 327 persons received their injuries while in houses, 243 in the open, 57 in barns, and 29 under trees. The circumstances attending the injury of the remaining 317 cases are not known.

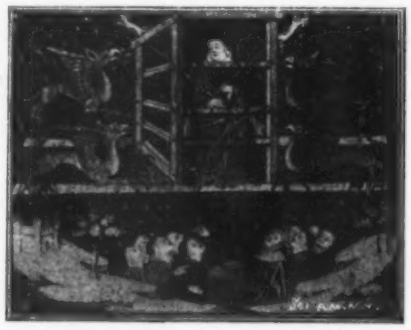
The foregoing statements briefly sum up the net results of the ravages by lightning in a single year. The summary itself tells little, nor can it, of the infinite variety of external circumstances attending the destruction of so many people. Some were stricken in their homes, some on the highways, some in the field or barn, and some while seeking temporary shelter under trees. It has been pointed out again and again that it is not safe to take refuge from a thunderstorm under a tree. Doubtless most of those who perished while under trees would be alive to-day had they remained in the open. It is also injudicious to huddle under thrashing machines, sheds, or in the so-called "grand stands" pertaining to race tracks or county fairs, especially under or near the flagstaff. Men, like animals, are killed not singly, but in bunches when they huddle together.

The greatest number of fatal cases occurred in the Middle Atlantic States, and the next greatest in the Ohio Valley and Tennessee, with the Middle and Upper Mississippi Valley a close third. The greatest number of deaths in any single State during the five years, 1896-1900, occurred in Pennsylvania—186—followed by Ohio with 135, and Indiana, Illinois, and New York with 124 each.

The greatest fatality from a single stroke occurred at Chicago, Ill., where 11 persons, huddled together in a zinc-lined shanty under a North Shore pier, met instant death by a single bolt.

FORERUNNERS OF MODERN INVENTIONS.

WE moderns, who pride ourselves on our submarine boats, our airships and the mechanical appliances that do half our work for us, are sometimes grieved to find that hundreds of years ago men of intelligence, if they had not the actual machines which we possess, at least had thought of them. Leonardo da Vinci, for example, made some wild, chimerical drawings of airships, submarine boats, mortars and mechanical devices, that to us seem far in advance of his day. But lesser minds than that of Leonardo conceived similar things. In a recently published book which bears the title, "Social England," may be found many a curious illustration of the ever-recurrent tendency of inventors to dream of things that may some day be possible. In the book in question are published two interesting pictures, reproduced here, in both of which Alexander the Great figures prominently. The first of these illustrates an airship in which the great Macedonian is drawn upward by griffin-like birds, who are induced to carry along the frame in which he is seated by meat which he holds on a pole. Based on somewhat sounder mechanical principles is the submarine boat pictured in the second illustration. The conqueror of Darius is let down into the sea in a glass barrel ostensibly for the purpose of scientific research. But the attack of a huge fish leads him to conclude that such researches are not for mortals. How the monarch managed to breathe in that tightly closed cask, the artist-inventor fails to show.



AN ANTICIPATION OF THE AIRSHIP.

AN OLD CONCEPTION OF A SUBMARINE.

SCIENCE IN THE THEATER.

THE National Academy of Music is continuing to mount the works of Richard Wagner, and its machinists are setting their wits to work to materialize upon the stage the scenes of the German legend, although this is not an easy thing to do.

The theaters that have attempted work of this kind have succeeded, as a general thing, merely in attaining a certain degree of grotesqueness; and neither the Paris Opera nor other Operas have always been successful in avoiding (what is almost an impossibility) the danger of falling into the same pit.

In "Seigfried," the last work mounted, it is a question of reproducing the conflict of the hero with the terrible dragon, Fafner, the guardian of the ring of the Nibelung. The monster is large enough, to be sure, but its motions are necessarily wanting in naturalness, and it would be preferable to have the combat take place in a slightly more subdued light.

There is nothing particularly remarkable about the machinery of the monster. Electric globes form the eyes, the lids of which are movable, and jets of steam issue from the mouth, the jaws of which are moved by a man concealed in the body, while other men move the huge tail, which is mounted upon an entirely separate frame concealed from the eyes of the spectators by the body when the latter is viewed from the front.

At a given moment the animal laboriously rises and then falls back; but all this is by far too destitute of naturalness, and we do not think it of interest to dwell upon this part of the machinery. It is in the less important accessories that we find some interesting applications of science to the stage. The first of these is the anvil, which, although built of wood and topped with a bar of iron that has not been in the fire, gives the complete illusion of a forge in operation, with particles of glowing iron flying about on all sides. It is unnecessary to state that electricity is employed in producing this effect. M. de Ceris, head of the electrical staff of the Opera House, has devised the following form of anvil for the purpose: The top of the anvil is covered at *A* (Fig. 1, No. 1) with a block of cast iron, *E* (Fig. 1, No. 2), a little over an inch in thickness, in which are formed grooves wide and deep enough to allow iron wires one-fifth of an inch in diameter to be placed in it without touching the metal at any point. These wires are all united at each end by a metallic crosspiece, *T*, insulated from the block of iron, which holds them firmly in place. They are so arranged as to project slightly above the surface of the block. The entire affair is interposed in the electric circuit of the theater, one of the poles connecting with the block of iron and the other with the wires. Since these two parts of the apparatus are insulated, no current passes; but when the actor gives a blow with his hammer or sword he establishes a short circuit between the block and wires, causing sparks and particles of burning iron detached from the wires to be projected at every stroke. The current should naturally be interrupted as soon as the hammer or sword that establishes the short circuit is removed, for, since it is very intense, it will sometimes form an arc between the insulated parts of the anvil. In order to prevent this a machinist stationed in the prompter's box follows the strokes of the blacksmith and, by means of a suitable switch, breaks the circuit after each blow, afterward immediately re-establishing it.

This anvil, moreover, must be so constructed as to be cleft in twain at the moment when Siegfried tests his sword upon it. One of the parts, *A*, remains in place, while the other, *B*, falls to the ground. A simple bolt that is withdrawn at the proper moment is all that holds the two parts together.

In the following act a bird must cross the stage, and, as it plays an important part and the eyes of the spectators are necessarily riveted upon it, it becomes necessary to obtain as natural motions of flight as possible. M. de Ceris has selected for this purpose a paper bird, the wings of which are set in motion by a twisted rubber string.

Everyone is familiar with this little device, which is sold in all toy stores under various names. But, since the flight of such a bird, when left to itself, would be quite irregular, the bird is steered by attach-

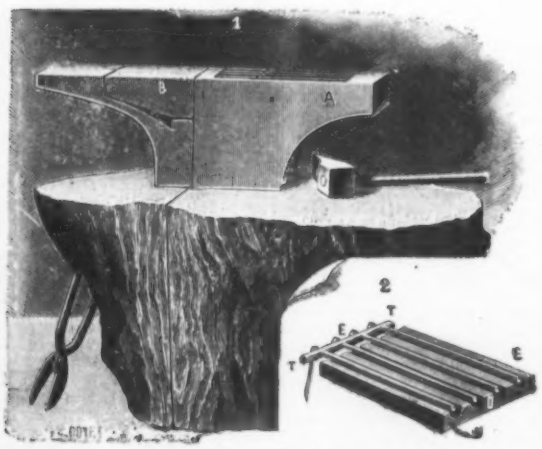


FIG. 1.—THE SIEGFRIED ANVIL.

1. General view. 2. Details of the grid upon which the short circuit is established.

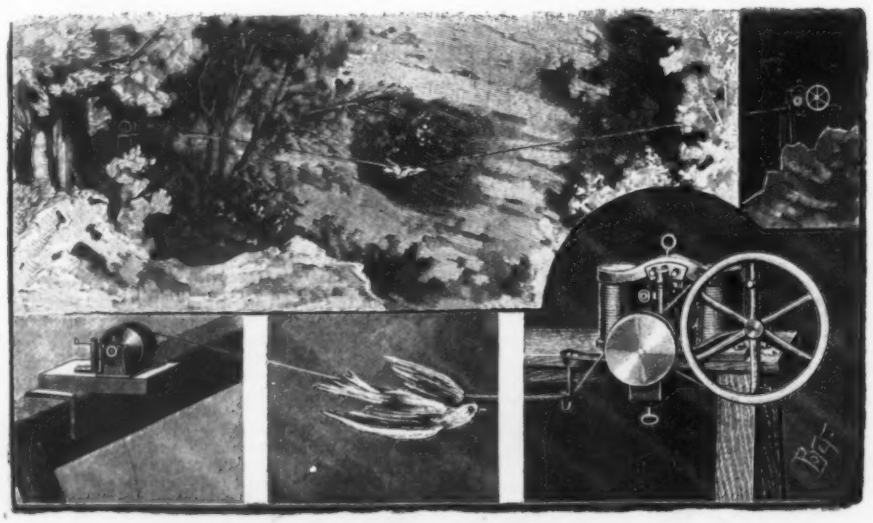


FIG. 2.—THE SIEGFRIED BIRD.

General view of the scenery and of the installation of the mechanism.

ing it to a fine wire that extends across the stage and is invisible even through the best opera glasses. One of the extremities of the wire is wound around a drum placed in the flies on one side, while the other end winds around a small windlass on the other side actuated at a constant speed by a very small electric motor of such small power that it can be stopped by pressing with the finger upon the drum carrying the wire; but will start again as soon as the pressure is removed.

By allowing the bird to descend by its own weight, and then braking the drum in order that the windlass on the opposite side may have time to wind up some of the wire, upward and downward motions are obtained, which, combined with those of the wings, give the appearance of flight in a state of liberty. In order to add to this illusion care is taken to cause the bird to pass in three different planes; and, for this purpose, there are required, in reality, three similar installations, one for each plane. But, since the three imitation birds are identical in appearance, and there is never but one of them visible at a time to the spectators, the latter have the impression that it is really the same one that has flown about at all points of the stage. These different artifices are, upon the whole, very simple, and herein, in our opinion, resides their principal merit, for, in the theater, it is not, as a general thing, the most complicated devices that produce the best effect.—For the above particulars and the engravings we are indebted to La Nature.

CHARLIER OIL-FUEL BRASS-FURNACES.

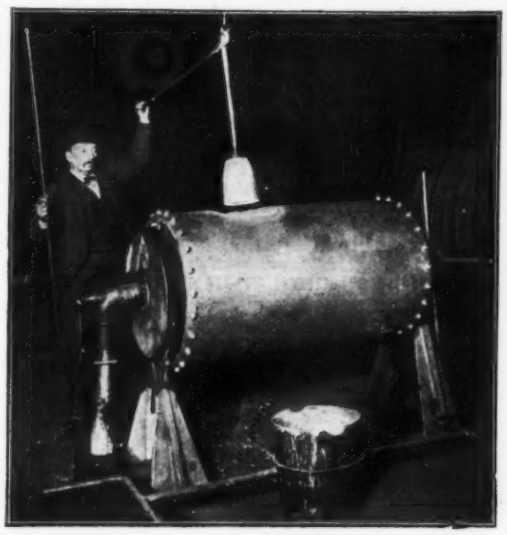
NOT a few efforts have been made in large melting establishments to use oil-burning furnaces. Although the results obtained have been promising enough, nevertheless the difficulties met with have led to a complete abandonment of the scheme. Chief among the difficulties experienced was that of obtaining complete combustion of the oil, as well as a proper distribution of the products of combustion, so as to secure a quick and even melting.

Our attention has been called to the invention of a native of France, H. J. Charlier, who has long experimented with oil-burning furnaces, not only for the melting of brass, but also for iron, steel and other metal. The furnace which we illustrate herewith is the product of his labor and is made by the J. W. Paxson Company, of Philadelphia, Pa.

The oil fuel used is of low test, so that it will not flash. In order that the requirements of the insurance companies may be complied with, the oil is stored in underground tanks and is pumped through pipes to the furnace. So far as the consumption is concerned, it should be mentioned that a 600-pound-capacity furnace will burn about 5 gallons per hour. A small Paxson-Champion blower is employed for the purpose of spraying the oil into the furnace, the pressure being about 3 ounces. The blast-pipe is led under the floor and has a cut-off a few inches from the point of discharge. A globe valve in the supply pipe near the other cut-off regulates the oil feed.

In form, the furnace is cylindrical. The material used in its construction is heavy steel plate. A fire-brick lining is provided, which is so graded that the molten metal will all drain to the outlet. In order to renew the lining—which is necessary only at intervals of four months—it is necessary simply to unscrew the bolts at one end of the furnace, upset the furnace, and fit the lining very much in the manner a cupola is lined. In order that it may be rolled over part way to present a new hot surface to the molten metal, or all the way for pouring, the furnace is carried on trunnions. The furnace is tilted by means of a hand-wheel.

In order to heat up the furnace, a piece of inflammable material is inserted and lighted, whereupon the oil and air are turned on. This preliminary heating is extremely rapid. After having been heated sufficiently, about half the charge is thrown into the furnace; the other half, particularly the larger pieces of ingot and scrap, is melted in the hopper at intervals of five minutes until the whole is dropped into the bath of molten metal within the furnace. Even though only a portion of the charge be melted, the furnace can



CHARLIER OIL-FUEL BRASS-FURNACE.

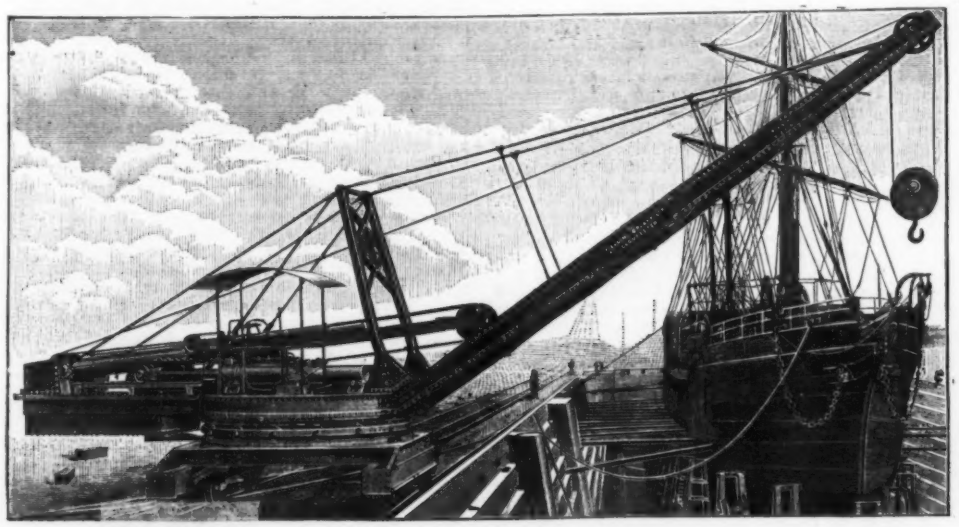
be rolled over and a pouring made. Small, intricate work, or heavy castings can be poured directly from the furnace into ladles, which are first heated by holding them over the charging hopper.

Within a 600-pound-capacity furnace, 600 pounds of copper and tin can be melted in an hour; 600 pounds of turnings in two hours; 500 pounds of new metal and 75 pounds of turnings in one hour; and 600 pounds of yellow brass in one hour; 500 pounds of iron or semi-steel can be melted in two hours; and 500 pounds of steel scrap in three hours. It is said that phosphor-bronze can be made in this furnace better than in crucibles. In order that turnings may be easily and thoroughly effected, the phosphorizer is suspended with an attached weight from an overhead pulley. The heat can be very nicely regulated, so that metals having different fusing points can be perfectly mixed.

The economy and efficiency of this furnace are said to be marked. Since crucibles are dispensed with their cost is saved. Since oil is used, the necessity of handling coke and ashes is avoided. Wherever natural gas is available the economy of the furnace is often higher than if oil be used as fuel.

TEN-TON HYDRAULIC GRAVING-DOCK CRANE.

THE accompanying illustration shows a 10-ton hydraulic graving-dock crane recently designed and constructed by Messrs. Fielding & Platt, Ltd., engineers, Gloucester, and erected at the new graving dock of the Wallsend Slipway Company, of Wallsend-on-Tyne. This crane is capable of lifting a load of ten tons through a height of 50 feet. It is fitted with a treble-ram arrangement, by means of which it can lift 3 1-3 tons and 6 2-3 tons, also with a corresponding reduction in the amount of power required. The crane is so arranged that it can be slewed by means of hydraulic pressure through rather more than a complete circle. It is fitted on wheels resting on rails which run all round the graving dock. Hydraulic pressure hydrants are placed at suitable intervals round the dock, so that the crane can be worked at any point round the side. The crane is so designed and the weights of the machinery so distributed round the turntable that it is well balanced, thus rendering the use of holding-down clips unnecessary. A platform is fitted from which the driver of the crane can control all the movements and have complete control over all the valves, at the same time that he faces the load. The crane has worked satisfactorily and has been found of great service.



TEN-TON HYDRAULIC CRANE.

ST. MARK'S AND ST. ANTONIO'S.*

TWENTY years ago the greatest art critic of the nineteenth century was waging an apparently unsuccessful war with the tasteless officialdom of Young Italy, which in those days was perpetrating the greatest atrocities against the historic monuments of the Land of Art. Ruskin, G. E. Street and others were to some extent successful at the time, and now those who have entered into their labors may, perhaps, enjoy a particular pleasure in seeing how changed are the times. Public opinion has completely gone over to the conservative side of the question; the "Restorers" are nowhere. This remarkable change can be studied especially well in St. Mark's. The atrocious "restorations" of thirty to twenty years ago are with us to-day, and the machine-made "Gothic art" of the period, with its crude coloring and lifeless drawing, covers scores of square meters of the wall space once occupied by ancient mosaics. Almost the whole of the mosaics of the narthex were "restored" at that time, and deplorable, indeed, are the results. Even the lapse of a quarter of a century has had no appreciable softening effect to change their hard-lined, misunderstood imitation of what may originally have existed in their places. They must go down, alas! to posterity as samples of the utter want of feeling for decorative art evinced by Italians in the latter half of the nineteenth century.

At the present time several works of reparation are going on in St. Mark's. The most important is the complete reinstatement of the mosaic, and the dome to which it is attached, which forms the covering to the south transept. This is being carried out with all the thoroughness so characteristic of Italians in works of the kind—and, indeed, in all building operations.* Other minor repairs to the mosaic are taking place in various parts of the church, and the same elaborate care is being manifested in every case. But how changed are the conditions under which this modern work is being executed from those in the days of Ruskin and Street! *Now* the object in view is to produce an *untouched appearance.*

The famous wavy floor of mosaic (its waviness thought by the credulous in such matters to have been intentionally designed to represent a "sea of life," but which in reality is due to bad foundations) is being patched here and there—but in a very different manner from the portion in the northwest aisle, restored in the taste of the period some twenty-five years ago. The present restorations are actually being made without leveling the pavement! Could anything more distinctly demonstrate the almost excessive conservatism which is now passing over the land. The Italians are, indeed, proving themselves masters in the craft of preserving ancient monuments, and although the conservation of the uneven levels in St. Mark's floor seems carrying the modern principles of reparation to an extreme, still the careful reproduction of the original with all its characteristic griminess is distinctly satisfactory, and an altogether more agreeable result than anything of the kind attempted in the old days.

St. Mark's has an unique history. At one time it was the center monument of a mighty republic, the chief temple of a nation much in the sense, perhaps, of what the Parthenon represented to the Greeks. And as such the peculiar Byzantine style of the building seems to have been most religiously preserved throughout the ages in a way which was almost unnatural. For we must remember that in the days when the Serene Republic was at the zenith of its wealth and splendor, the new principles of art of at least the Renaissance, if not the pseudo-classic schools, were generally accepted, and to men imbued with such ideas the mosaic interior of St. Mark's must have appeared but a "goffa" (to use Vasari's word) monument of their rude and barbarous forefathers. It is, indeed, surprising that St. Mark's did not share the fate of old St. Peter's or the other basilicas of Rome, for Venice was not a deserted capital like Ravenna, but a center of the revival of the new studies in art and literature. How often Palladio, or Scamozzi, or their fellow workers in the great change of taste in the sixteenth century, must have contemplated with pleasurable anticipation the remodeling of the old building! As we know from their writings, they could but have looked upon such a building as quite beneath criticism from their standpoint of exclusive admiration for the classic style. And certainly the neo-classicists may be allowed to have had some reason on their side. St. Mark's is not an example of architecture in the organic or true sense, any more than certain other great churches of Italy which are in what the Italians call the "fragmentary" style, such as Pisa, or Siena, built up of second-hand materials in a way which may be highly decorative and artistic, but scarcely to be deemed the highest type of architecture. Critically examined, St. Mark's consists of little more than a huge vaulted shell of brickwork, lined and decorated with precious marbles and mosaics; but not one of its innumerable marble columns was ordered at any quarry for the purpose; all were stolen from Levantine buildings and sent home as ballast in returning empty galleys of the period. Its glass mosaic decorations are partly remarkable on account of their being used nowhere else in Venice. Within the region of the lagunes there is nothing exactly resembling St. Mark's either in construction, scale or mode of decoration, except St. Antonio's at Padua, which seems a more perfected example of the same system of building. The more ancient Duomo of Torcello has little in common with it beyond the mere circumstance of a similar decoration in mosaic; in other respects this venerable church belongs to the series of Basilicas of Ravenna.

Probably the chief reason for the escape of St. Mark's from the vandalism of the pseudo-classic age, in addition to its evident incompatibility of plan and construction with the models of the later taste, was the completeness of its mosaic decorations. Few, if any, buildings of the size were so complete in a mediæval style when the great change of the fifteenth

* The Builder.

* And in nothing is this thoroughness so conspicuous as in the almost monumental scaffoldings which are made use of on such occasions as the present. In more northern countries a comparatively rough arrangement of poles and boarding tied up with ropes, and with a patchwork screen to preclude inquisitive investigation by the public, would be considered sufficient. Here in Venice, as at the still more imposing work going on in the Baptistry of Florence (which has already been several years in progress), the scaffolding has been elaborately constructed of carefully fitting timbers, with a neat ceiling of boards dividing off the whole space occupied for the "restoration" from the church below, so that many visitors to the church may be quite unaware of so important a work being in progress, so neatly is the whole operation carried on without affecting the floor-space below. This self-supporting scaffold rests entirely on the great main cornice at the base of the dome; the space screened off within is lighted by the little windows which form a peculiar feature of Byzantine domical architecture, and in this case are within the curve of the dome.

century took place. The mosaic pictures which were added by certain celebrated artists at that period were probably in the form of restorations or, rather, substitutions; such, for instance, as the figure of St. Mark—attributed to Titian—over the central west door, which was clearly a mere replacement of the much older mosaic of a totally different style. To alter the basilica at all would have involved the complete sweeping away of its chief and characteristic feature, the mosaic work and marble sheeting which covers every square foot of its brick walls. St. Mark's was thus one of the few mediæval buildings which benefited by a completeness, which, although preventing that picturesqueness associated with a mingling of styles, at the same time preserved it as a curiosity on account of its unique character. All through the later centuries the golden, glittering splendors of the mosaic doubtless excited the admiration of the Venetian populace, and the fact that great artists like Titian associated their names with such a style of art would also naturally tend to check any suggestions which the architects of the period would make for converting the basilica into one of the coldly correct classical reproductions so often attempted in those days. But notwithstanding the influences surrounding and threatening its very existence, St. Mark's escaped and survived to our modern days for the admiration of a generation more eclectic in taste.

As has been remarked, almost the only building which at all resembles St. Mark's is the neighboring church of St. Antonio in Padua. In this latter the same massive piers support the same kind of domes, and the general appearance of the building suggests that a similar use of mosaic was originally intended, although not an inch of such a decoration was ever executed. St. Antonio's was evidently built, or at least finished, long after the change of taste took place; when mosaic was no longer the medium of an artistic expression to which the usual developments of an architectural style such as the Byzantine seem rather sacrificed. Both St. Mark's and St. Antonio's belong to a period of transition from the ancient basilica of the Ravenna type to the church of the short-lived "Gothic" style of Italy. In St. Antonio's the beginning of the pointed arch mode of construction, the striving for lofty proportions, and, above all, the introduction of the central European type of east end, with its ambulatory and chêvet of encircling chapels, all belong to the later style; while, at the same time, a very strong resemblance (especially in plan) to the basilica of Venice suggests the possibilities of a still finer example, as originally designed, of a mosaic-lined interior of grand proportions which was never carried into effect. In St. Antonio's the traditional colonnades of the ancient basilica, which survive to some extent in St. Mark's, are eliminated; the vaulted, domical interior takes the place of the older long-drawn aisles with lean-to roofs. But unfortunately by the time this grand building was completed the mosaic art had been practically abandoned for the more exact fresco painting, with all its astonishing adaptability to decorative work. The huge brick shell, instead of being covered internally with glass mosaic, as was probably, if not certainly, the intention of its original designer, was treated in the style of a later period and presented a sufficiently splendid effect until its frescoes were covered up with the whitewash of the sixteenth century.

At the end of the eleventh century St. Mark's seems to have been remodeled as we see it at the present day. St. Antonio's was commenced—that is to say, designed—almost immediately after the death of its tutelary patron in 1231, but according to some accounts it was not finished for decoration until the middle of the fifteenth century. Roughly speaking, rather more than a century intervened between the dates of the two greatest monuments of Venetian architecture, and it is curious to notice what an advance in methods of construction and in general design had taken place in the interval. The church of Padua is a magnificent conception from every point of view, while, on the other hand, the heavy proportions and want of a distinctly architectural character and style in St. Mark's is scarcely redeemed by the richness of its mosaic. The plan of St. Antonio's is clearly a lineal descendant from that of St. Mark's, but the suppression of the Byzantine narthex inclosing the west end, and the introduction of the pointed arch as a dominating feature in place of the older style of construction, create an altogether different effect. Indeed, to the ordinary beholder there is not very much resemblance between the two churches at first sight, but, perhaps, if we allow ourselves to imagine the interior of St. Antonio's a blaze of mosaic color and gilding, as it was doubtless intended to be by its original designer, the resemblance between the two becomes clearer, and the imposing character of such a style of architecture and decoration is sufficiently evident. It is to be regretted St. Antonio's was never completed as a consummation of the Italo-Byzantine style—a style of particular originality and magnificence.

As has been said, the interior of St. Mark's, owing to its completeness at an early date, escaped to a great extent the alterations which were customary in churches during later ages. But St. Antonio's, on the contrary, has been one of those unfortunate buildings fated to perpetual remodeling and transformation. The magnificent works of art with which it is crowded are in themselves perfect, but they were designed by men who could ruthlessly whitewash the frescoes of the Middle Ages. The interior appears to have been entirely painted—the domes, vaultings, walls, pilasters—during the fourteenth and fifteenth centuries. These paintings were whitewashed, probably in the sixteenth century, when the numerous additions of that period were made to the interior. At a still later date the basilica suffered from a fire which would necessitate an additional coat or two. Not only the mural decorations of the main body of the church, with its domes, etc., were covered up, but the side chapels of individual character, which always give to an Italian church such an additional interest, were reduced to the same white uniformity.

At the present day a scheme is on foot to restore the interior to its pristine splendor; but not, of course, with the idea of introducing the mosaic style which the building was so evidently designed for. The frescoes of the westernmost dome have been laid bare from the whitewash in a somewhat deplorable condition, but they are sufficiently preserved to allow of a perfect reproduction of the original painting. Large designs have been prepared for the purpose by a firm of decorative artists, and these are exhibited in the church with a view of attracting funds for the work. To criticise these productions is a little difficult, because even the large-scale drawings of so vast a building (about 100 feet in height to the centers of the domes) are necessarily inadequate to give a true impression of what is intended. It is to be hoped that these designs merely represent an approximation to the eventual carrying out of the work, and that the frescoes will be repainted on the original lines as far as may be. These drawings have the unfortunate character of most modern decorative work: they are too evidently the result of study and copyism, made in an office or studio by a designer whose only occupation is that of making such small drawings of work to be carried out in execution by another hand. One of the eastern chapels is being at present decorated on a separate scheme as the national offering of a Polish committee.

Whatever the present scheme for restoring the ancient frescoed interior of St. Antonio's may be, there is no doubt the newly-instituted government department for the preservation of the antiquities of Italy will not permit anything but a most accurate copy of the remains still in existence beneath the whitewash.

BORAX AND ITS MANUFACTURE.

QUITE one of the most interesting illustrations to be found in various treatises on pure and applied chemistry is that which depicts the manufacture of boracic acid from the lagoons of Tuscany, though the works themselves are but very rarely included in the scheme of sight-seeing which the tourist of to-day maps out for himself when visiting the land known in ancient history as Etruria. This is, perhaps, hardly a matter for surprise, as art and classical lore, coupled with a love of the picturesque in nature, supply the incentive, in nine cases out of ten, to Italian travel, and in their domination leave but little room in the mind for the intrusion of scientific subjects. Besides, the almost total neglect which this interesting branch of Italian industry has experienced at the hands of tourists may be largely attributed to the fact that the scenes of operation are somewhat remote from the beaten tracks, where the lions of art are to be found in close proximity to modern hotels and quick railway transit. If to these excuses we add the not unimportant one, that comparatively few tourists in Italy from across the Alps have any acquaintance with the language of the country—without which knowledge it is impossible to prosecute any scientific studies—enough will have been said to afford an explanation of the fact that so little is generally known of an industry which dates its inception back to the year 1774, when an apothecary of Florence demonstrated the occurrence of boracic acid in the lagoon of Monte Rotondo. We are not, of course, on the present occasion writing a popular article, and it is quite outside our intention to occupy space by reverting to what may be found described in so many works on chemistry; but the vicissitudes which the boracic acid and borax manufacturers have undergone in recent years seem of sufficient interest, if not actually of importance to warrant a few words by way of explanation and comment; more especially as these bodies are finding increased application, not only in manufactures of various sorts, but also in the ramifications of domestic economy. With regard to one of these applications, that of food preservatives, it is now more than a twelvemonth since we commented on the situation as at present existing, and expressed the hope that the Royal Commission on food preservatives would shortly issue their conclusions. The country is, however, still without this important document; and it is sincerely to be hoped, in the interests of the health of the community, that its production will not be much further delayed; seeing how much we are behind other countries in deciding what is and what is not to be used with impunity.

Although for preservative purposes boracic acid and borax are indiscriminately used, it is important when dealing with the manufacture to distinguish clearly between these bodies. Boracic acid is the hydrate of boron trioxide, having the formula $B(OH)_3$, while borax is the compound of this oxide with soda, and may be called by the more descriptive name of biborate of soda. The term "vicissitude" was recently used, and truly it has its full significance, in relation to a product which, in the course of a comparatively few years, has seen a drop in value from £45 to £13 per ton, which is the market quotation to-day. It is this great fall in price which has brought about the decline and partial stagnation of the once very important Italian industry. The cause of the drop is found in the discovery of borax material in other parts of the world, notably in Chili and in Argentina. The large deposits which have there been found are quite different in their nature—though as regards their origin one does not care to be precise—from those of Tuscany, as they consist in some cases of already formed borax existing in the niter deposits, and in other cases of the mineral borocalcite, or borate of lime. The quantity of these deposits as yet discovered being such as to dissipate any idea of their rapid exhaustion, it is not surprising that the zeal with which they have been worked has led to overproduction, with its necessary consequence of a steady decline in value, and this despite increased demand. It is estimated—and there is every reason to suppose that the figure is correct—that the world's output of borax at present amounts to 50,000 tons, of which from 40,000 to 45,000 tons are produced by the Borax Consolidated, Limited, the large combine which was effected in the trade a year or two ago as the only means of saving individual competitors from disaster. Although a certain amount of borax is manufactured from Tuscan boracic acid, yet the main quantity is prepared from the mineral just referred to. The Argentine deposits recently discovered show on assay 40.65 per cent of boracic acid. This mineral costs for production and long transport to Buenos Ayres £5 4s. per ton, and about £1 would have to be added for freight to a port in the United Kingdom; it is therefore quite possible that Chili, which has at present practically a monopoly in the supply of our raw material, may experience competition before long from Argentina.

Since the formation of the Borax Consolidated, Limited, which concern sought to obtain control of the sources of supply of the raw product, exceptional activity has been exerted by outsiders to discover new deposits beyond the control of the combine; but such efforts have not been attended with particular success. It cannot, however, be said that the prospects of the business have been bright enough to inspire competition, and with very few exceptions the monopoly of the great borax company has not been assailed. The process of manufacture is really such a simple one that any chemical manufacturer with spare room at his disposal could take it up if he thought it worth his while; and, indeed, there are two or three at the present time who, at the prospect of a reasonable profit, would set their idle plants again to work. At present prices, however, the prospect is not sufficiently alluring, so the small manufacturer prefers to concentrate his attention on something that gives better returns. It may conduce to completeness if a synopsis of the manufacture is attempted; though it must not be taken that what is here given is rigidly adhered to by all manufacturers; for some of them have, in the light of acquired experience, introduced varieties of procedure, this being particularly noticeable in the somewhat difficult crystallizing process.

In the manufacture of borax from boronatrocalcite, which we have previously referred to under its more common though less accurate name of borate of lime, four distinct operations are necessitated, viz.: (1) Boiling of the mineral with soda; (2) working up the residual mud; (3) fine crystallization; (4) working up the lyes. In the first operation the mineral is ground in water raised to the boiling point, and calcined carbonate of soda is added in slight excess. The clear solution which is obtained when the boiling is over is run into rectangular iron tanks and allowed to crystallize. This is but a very impure product, containing 40 to 50 per cent of borax only, the rest being sulphate of lime and common salt. About the second operation, which is concerned with the washing of the precipitated mud from the boiling process, there is nothing that needs special mention, the process being the simple one of washing with water and subsequent evaporation to the crystallizing point. The third process is that of obtaining the pure borax from the crude crystals by recrystallization; and although simple enough in theory, it requires considerable knowledge combined with some ingenuity for its successful operation. The rationale of the process depends upon the fact that at a certain temperature, and at a definite degree of concentration, borax will crystallize out from its admixture with the impurities mentioned above. An important point about the process is to see that the borax crystals are of that variety containing ten molecules of water; because if the solution is too concentrated, crystals containing only five molecules of water are formed, thus leading to a commercial loss. The vats used in the crystallizing process are of the rectangular iron variety, cased in wood, the interspace being filled with some non-conducting material in order that equable conditions of cooling may be attained. The vats having been filled up, are covered over and allowed to stand untouched for as long as fourteen days, when the surface will be found crusted with borax crystals, while the sulphate remains in solution and can be run off. The fourth operation mentioned, and which has reference to working up the mother liquors for the small quantities of borax they contain, is hardly of sufficient importance to receive attention in a synopsis, even if it could be adequately treated in a summary fashion.

It is in the form of borax that the great bulk of boracic acid goes into commerce, though the refining of crude boracic acid from Tuscany occupies part of the attention of the English borax manufacturer; this product being sold as the acid, and not now being used—or at least not to any appreciable extent—for the manufacture of borax, as in the days before the borate of lime deposits came to be utilized. Some idea of the bulk of the borate business may be gathered from the figures for Chili alone: in 1900 the exports were—borate of lime, 13,178 tons, while a small quantity—about 24 tons—of borax was also exported. Although British borax goes practically all over the world, and in many places in increasing quantities, there is one instance of a decline, and this of so serious a nature as to merit the term of annihilation. We refer to the United States, where the McKinley tariff has worked with very sinister results for the British industry; though it is hardly to be wondered at that a country with such natural advantages should take steps to develop them. To give the values of the imports into America from the United Kingdom for the last decade, we find that, although the value in dollars rose from $144,494 in 1891 to $166,021 two years later, since then the decline has been general and regular, the figure for 1900 being only $8,779, which portends total extinction at an early date. With regard to the uses of borax other than for food preservative and domestic purposes, reference may be made to the pottery trade, the neighborhood of Stoke-on-Trent having been the scene of its manufacture, and the most important field of its application from the inception of the industry in this country.

No doubt those still engaged in the trade look back wistfully to the time when the substance was selling at £40 and upward per ton, for it was then possible to make something more than a bare living out of it, which is all that can be expected at to-day's prices. This remark does not, of course, apply to those who are interested in the great combination, but to those who try to carry on business outside it. The strong point, of course, with Borax Consolidated, Limited, is the control of the raw product both in South America and Italy; the difficulty of obtaining supplies of raw material, except at prices agreeable to the combination, is a very potent deterrent to those who would wish to challenge the supremacy of the big company in the finished product. And it is difficult to see how any effective competition can be estab-

lished; because, even if new deposits of the mineral are discovered, it is part and parcel of the policy of the combine to buy them up, or, at any rate, to obtain a hold over the output. At the beginning of November a considerable amount of comment was caused by the announcement that borax was reduced £2 per ton; and in the absence of any explanation of this stroke of policy, it is not surprising that speculation was rife. As trade has been good of late, there seemed no reason for this reduction, which certainly had not the approval of the small manufacturers; and there seems only too much reason to suppose that it is a diplomatic act on the part of the combination to make things uncomfortable for the small producer. We say this with some reserve, as we are not in the confidence of the prime movers, but such things have not been unknown in commercial history, and those who have the key of the position by means of controlling large capital often display a tendency to use their power in a way which is commendable more on strict business grounds than from any ethical point of view. Not that we wish to sit in judgment on those whose proceedings do not happen to fall exactly in line with our preconceived ideas on any subject; but we must say we view with some concern the strenuous endeavors which are being made at the present day on the part of big corporations to remove the small independent operator from his position; and we trust that it will be some time yet before the bulk of small chemical manufacturers will be in the position of those who have had to yield to the dictates of the big alkali combination: with which observation these somewhat discursive notes on borax may fitly come to a conclusion.—Engineering.

LAC AND THE ART OF LACQUERING.*

THE industrial use of lac in the extreme Orient dates from a far-distant age, and appears to have originated in China. Surpassing in skill those who had imitated them in the art, the Japanese have attained decided superiority. This has been attributed at times to the quality of the material, the trees that nourish the lac-producing insects finding in Japan an exceptionally favorable soil for their development, and, again, to the ability of the operatives. But, according to M. Dumontier, it appears, above all, due to the more delicate esthetic taste of the Japanese.

Lac trees are found in Tonkin, in Cambodia, in China, and in Japan. The lac of Cambodia produces a transparent polish very much esteemed. It is prepared by processes kept secret, and is sold at high prices. The sap of the old trees seems to be preferred. The *Melanorrhea laccifera*, called by the people of Cambodia *Mereak*, is a large redwood tree, which grows in abundance throughout the country and on the island Phu-Quoc. It produces the most esteemed lac of that region. At the end of four years after planting it has attained a height of two to four meters, and is then able to support the incisions which furnish the precious fluid.

At Tonkin the lac tree grows in nearly all the mountainous regions, especially in Houghoa, Luyenquan and Thai-nguyen. It is a shrub, which, according to Balauta, is three to four meters high; its slender trunk is erect; its polygamous flowers are greenish-white, and the leaves are imparipinnate. The wild species is very similar to the cultivated, and is found in woody places on the Black River. The tree is vigorous in growth, flourishes in all soils, and accommodates itself even to rocky places, unsuitable for other cultivation. Although doubt prevails as to the scientific determination of the nature of the lac tree of Tonkin, Balauta believes that he can identify it with the *Rhus succedanae of* Linneus. The seeds are gathered in October, and the natives soak them for three or four days in water, the germination usually commencing in about forty-eight hours.

In China the lac tree occupies a very extended geographical area, stretching from the mountains of Tche-Kiang to the extremity of the empire. The centers of production are Hou-Pe, Chen-Si, and Gse-Lchonen in the west. The lac most esteemed by the Chinese comes from the *Terminalia vernicia*.

It is in the provinces of the north of Japan that the *Rhus vernicifera*, or lac tree of that country, is abundant. It is vigorous and grows to a height of twelve meters. Its bark is whitish, and its imparipinnate leaves are two or three times as large as those of the Tonkin shrub. The quality of the sap improves with the age of the tree; it is harvested in April and October.

The art of lacquering includes various steps, which are divulged as little as possible; without them nothing but a varnish of good quality would be realized. Thus in Tonkin, where the abundant production is the object of an important trade with the Chinese, it is so used only for varnishing, while in China the same product from the same sources contributes to most artistic applications.

When the Annamites propose to lacquer an object, a box, for example, they first stop up the holes and crevices, covering all the imperfections with a coating of diluted lac, by means of a flat, close, short brush. Then they cover the whole with a thick coating of lac and white clay. This clay, oily to the touch, is found at the bottom of certain lakes in Tonkin; it is dried, pulverized and sifted with a piece of fine silk before being embodied with the lac. This operation is designed to conceal the inequalities of the wood and produce a uniform surface, which, when completely dry, is rendered smooth with pumice stone.

If the object has portions cut or sunk the clayey mixture is not applied, for it would make the details clammy, but in its place a single, uniform layer of pure lac.

In any case, after the pumicing, a third coating, now pure lac, is passed over the piece, which at this time has a mouse-gray color. This layer, known under the name of *sou lot*, colors the piece a brilliant black. As the lac possesses the remarkable property of not drying in dry air, the object is left in a damp place. When perfectly dried the piece is varnished, and the desired color imparted by a single operation. If the metallic applications are excepted, the lac is colored only black, brown or red.

The following formulas are in use:

Black.—One part of turpentine is warmed for twenty minutes beyond the fusing point; then poured into three parts of lac; at the same time *pheu deu* (copperas) is added. The mixture is stirred for at least a day, sometimes more, by means of the *cai vay*, a large paddle.

Maroon Color.—This is prepared by a process similar to the preceding, replacing half of the copperas by an equal quantity of China vermilion.

Red.—The lac, previously stirred for six hours, is mixed with hot oil of *trau*, and the whole is stirred for a day, after which vermilion is added. The latter should be of good quality, so as to have it brilliant and unchangeable.

The operation of lacquering is then ended, but there are parts to be gilded. These are again covered with a mixture of lac and oil of *trau*. When this layer is dry the metallic leaves are applied, which are themselves protected by a coating, composed also of lac and oil of *trau*. All these lac and oil of *trau* mixtures are carefully filtered, which the natives effect by pressing the liquid on a double filtering surface formed of wadding and of a tissue on which it rests. It can only be applied after several months when the metallic leaf is of gold. In the case of silver or tin the protecting coat can be laid on in a few days. It favorably modifies the white tints of these two metals by communicating a golden color. The hue, at first reddish, gradually improves and acquires its full brilliancy in a few months.

Little information is procurable concerning the processes employed by the Chinese and Japanese. The wood to be lacquered should be absolutely dry. It receives successive applications, of which the number is not less than thirty-three for perfect work. When the lac coating attains the thickness of a half centimeter it is ready for the engravers. The Chinese, like the inhabitants of Tonkin, make use of oil of *trau* to mix with the lac, or oil of *aleurites*, and the greatest care is exercised in the drying of the different layers. The operation is conducted in dim-lighted rooms specially fitted up for the purpose; the moisture is maintained to a suitable extent by systematically watering the earth, which covers the walls of this "cold stove."

In Japan when the wood is well prepared and the faults have been corrected with pure lac it is dried, pumiced and covered with a coat composed of crushed flax mixed with glue. Then a layer of lac is applied and covered with a fine linen fabric, which should perfectly adhere in all its parts. This first preparation, suitably dried, serves as a foundation for the successive applications of thirty-three layers. Each coating is rubbed with a fine-grained stone before drying in the moist chamber. This is done with the greatest precaution, so as to avoid impurities and dust. The last polish is obtained by rubbing with the powder of calcined deer horn. The piece is then ready to receive the application of gold or of silver, which is effected as follows:

The design to be reproduced is drawn on very fine paper prepared with a mixture of glue and alum, and on the back of the paper the outlines are traced with a brush of fine rats' hair, dipped in lac previously boiled over a brisk charcoal fire. This paper is then applied to the object to be decorated, and it is made to adhere by rubbing with a spatula, either of *minoki* wood or of whalebone. When the paper is removed the design is found transferred damp and is rendered more distinct by the application of a white powder by means of a piece of wadding. With one of these transfer papers twenty reproductions can be secured, and the lines can be retraced with the boiled lac, it is said, so as to procure copies almost indefinitely. The outlines remain damp in consequence of the use of the boiled lac, and imperfections can be corrected. In this case the outlines are retraced with a pencil of hare's hair lightly charged with a preparation of lac not boiled. This operation is delicate and requires great care not to displace the lac from the original outlines. When ended the whole is covered with fine gold, silver or tin powder, as desired; the powder is applied by means of a piece of wadding.

If the object to be thus decorated is of large dimensions the process is conducted on separate parts, and at each step the piece is placed in a damp closet tightly closed, so as to exclude the dust. When the metallic coating has hardened sufficiently the piece is taken out, and the design is covered with a fine transparent lac laid on with a brush of hares' hairs. The gilding or silvering of the succeeding part is never attempted until the preceding has been completely dried in the damp chamber.

All the parts of the object are finally rubbed with a piece of camelia-wood charcoal in order to equalize the thickness, and then polished with the fingers moistened with a mixture of calcined deer horn powder and oil.

Independently of its use in the arts, lac is susceptible of various industrial applications. It serves notably in mixture with oils for the production of the most esteemed varnishes.

For some years the attention of the scientific and industrial classes of Europe has been particularly attracted by this remarkable product, which can be furnished readily and abundantly by our own colonies. Perhaps the day is not distant when it will become to us a profitable source of income.

* Translated from the Revue de Chimie Industrielle for the SCIENTIFIC AMERICAN SUPPLEMENT.

WEIGHTS AND MEASURES USED IN THE PHILIPPINES.

THE Division of Insular Affairs, Department of War, has prepared an interesting account of the weights and measures in use in our Philippine possessions.

The extension of commercial intercourse between the United States and its Philippine possessions is attended with great inconvenience and expense, growing out of the complicated system of weights and measures in vogue in the islands. As compared with the United States denominations and values they are difficult to acquire and still more so to execute, either in transactions or accounts.

When Magellan, only twenty-nine years after the discovery of America, took possession of Mindanao in the name of Charles I., King of Spain, and the successors of that unfortunate navigator, notably Legaspi, continued the exploration of the archipelago, the Spaniards found a remnant of a once advanced civilization on all the larger islands.

The inhabitants, particularly of Luzon, had gold, copper and other products to offer in exchange for the silks and merchandise generally of the mainland of Asia and the rich islands to the south. Where there was trade there was naturally a knowledge of value, and, necessarily, methods of subdivision, measurement and equivalents.

For centuries unknown as far as recorded history goes, China has ruled the commercial transactions of the oriental world. The empire gave its measures of value, it is unknown how long before, but for nearly four centuries since the islands have been ruled from the west, and the same to the other archipelagoes to the south and to India.

The most ancient and also the unit of current commercial intercourse in the far East is the Chinese liang or ounce of "sycee" (more familiarly known in Eastern commerce as the tael), or fine pure uncoined silver in a lump or ingot called a "shoe." As a measure of value the liang or tael is one-third heavier than a United States ounce; 16 (sixteen) liangs equal one kin or pound. A "shoe" usually weighs fifty liangs or taels, but there are smaller "shoes" called tings of four to six ounces of silver. The value of the liang or tael was set at one and one-third pounds avoirdupois in the earlier commercial movements between the British East India Company and China and the Philippines and other eastern archipelagoes.

While the tael is the unit denomination of value and weight it is only so in its former character as a money of account, and is subdivided into tenths (tsion or mace), into one-hundredths (fun or Candareens), and into thousandths called li, to this extent far more ancient as a decimal system than that proposed by the French Academy of Sciences 102 years ago.

The price of silver bullion regulates the value of the liang or tael at the time of the transaction.

The Haikwan or Custom House tael is the standard weight and value recognized in the custom houses of the thirteen treaty ports of China (each of which, also, has its own tael) in all transactions and is also used among the Chinese and other Eastern traders and merchants in their commercial dealings in the Philippines. The March, 1902, United States Treasury valuation of the fluctuating currencies quotes the Haikwan tael at $0.68 United States cents weight of "sycee."

In general 1,000 Mexican pesos (dollars) equal 720 taels weight of "sycee."

It might be said in passing that the cash or tsien of copper alloy, the only coin current or money of China equal to about one-tenth to one-fourteenth of an American cent, is a subdivision representing one-thousandth part of the value of the liang, tael or ounce.

The pioul psoul, a weight not only common to the Philippines in its enormous hemp shipments, but throughout China and the East, is equal to 100 kin or catties, equal to 133 1-3 United States pounds.

The catty, also a common term in the Philippines, is a foreign name for the Chinese kin or pound.

The quintal, also in common use in the Philippines, is the ancient French denomination equal to 100 livres, about 108 pounds avoirdupois. The metric quintal is 100 kilogrammes, equal to 220.46 United States pounds.

In addition to these weights and measures of commerce the Philippine people in their local transactions have their native measures in the sale of rice and paddy by the cavan or caban and its fractions (dry measure) as follows:

4 apatans	1 chupa.
8 chupas	1 ganta.
25 gantas	1 cavan or caban.
1 ganta	3 liters or 3.1701 United States quarts.

The equivalents of which in United States measures are:

1 apatan	0.16375 of a pint.
1 chupa	0.675 of a pint.
1 ganta	2 quarts, 1 2-3 pints.
1 cavan or caban	10 gallons, 3 quarts, 1 pint.

Illustrating the two systems commercial and local, rice of foreign importation is weighed and quoted by the picul, or 137.9 United States pounds, subdivided as follows:

16 taels	1 catty.
10 catties	1 chinanta.
10 chinantas	1 picul.

The native grain and liquid measures in the Philippines are:

1 cavan dry	25 gantas equals 75 liters.
1 cavan dry	3.47 cubic feet.
1 ganta, 8 chupas	3 liters, 2.734 quarts.
1 chupa	⅜ liter.

The following weights and measures of Spanish application are still more or less in use.

Arroba (dry) equals 25 libras, equals 25.3664 pounds.

Arroba (liquid) equals 4.263 gallons.

League (judicial) equals lineal measure 2.634 United States statute miles.

Libra (weight measure) equals 1.0144 pounds.

Milla (lineal measure) equals 1,700 yards, 5,280 United States feet or 1600.3 meters.

Pia equals lineal 0.9478 foot.

Quintal (dry) equals 4 arrobas, equals 101.44 pounds.

Ton (space measure) equals 40 cubic feet.

Ton (weight measure) equals 20 metric quintals.

Vara (lineal measure) equals 0.914117 yard, or 33.384 inches United States.

One quinon (land measure, square 100 loanes) equals 2.79495 acres.

The picul varies in different countries as follows:

Borneo and Celebes, 135.64 United States pounds.

China, Japan and Sumatra, 133 1-3 United States pounds or 100 kin or catties.

Java, 135.5 pounds.

Philippine Islands, 137.9 United States pounds.
In the Philippines it varies locally.
One picul Philippine (hemp), 130.45 United States pounds.
One picul (sugar), 140 United States pounds.
One hundred kins or catties (China), 133 1-3 pounds.
Sixteen piculs equal one United States ton.
Two piculs equal one bale (hemp).

Under the statute, July 28, 1866, section 3509 Revised Statutes, it was made lawful throughout the United States of America, in current transactions and contracts, to employ the weights and measures of the metric system. In section 3570, also Revised Statutes, a schedule of terms, weights and measures in the metric system and equivalent in terms in the United States is given and made lawful in computing, determining and expressing customary weights and measures. The act of September 17, 1901, enacted by the United States Philippine Commission, "to revise and amend the tariff laws of the Philippine Archipelago," section 9, provides that "the metrical system of weights and measures as authorized by sections 3569 and 3570 of the Revised Statutes, and at present in use in the Philippine Islands, shall be continued."

The meter is equal to 39.37 inches. The liter is equal to 1.0567 quarts, wine measure.

The kilogramme is equal to 2.2046 pounds avoirdupois.

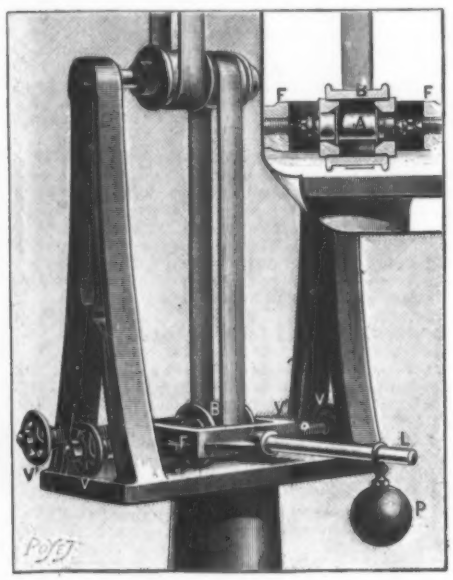
To which may be added:

The kilometer equals 0.62137 United States mile.

In the pending legislation in Congress concerning the Philippine Islands the metric system is proposed as the standard for transactions of commerce and account.

MACHINE FOR TESTING BICYCLE HUBS.

WHATEVER be the precision of the mechanical pieces that now enter into the construction of bicycles, and whatever be the quality of the metal employed in the manufacture of the latter, it nevertheless sometimes happens that a bicycle, after being put together, exhibits defects due, as a general thing, to negligence on the part of the mounters or some flaw in the metal that has escaped the most attentive examination. Let



MACHINE FOR TESTING BICYCLE HUBS.

us add that, as happens with railway cars that are sent empty upon short trips in order that their axles may become polished, the machines frequently run easier after a few days of service.

Such are the considerations that have led the Société pour la Fabrication des Cycles to construct a special machine for testing the running of bicycles. The arrangement of this apparatus may be easily understood from an examination of the accompanying figure. It is carried by a vertical frame, and the hub, *A*, to be tested, secured between screws, *V V'*, is set in revolution by means of pulleys installed at the top of the apparatus and actuated by a belt that takes its power from any sort of transmission. A graduated lever, *L*, attached to the frame, *F*, in which the hub is secured, permits of submitting the latter to a load, *P*, that may be varied at will. It is thus possible to submit the revolutions of the hub to a forced operation that may last for a variable length of time.

From the very beginning, this machine has afforded a means of making comparative experiments of the most interesting character. A lot of hubs from different sources, for example, were submitted to tests in which they were exposed to a load of 175 pounds and to a running speed of 18.5 miles an hour. At the end of 8 hours of such work, which, it must be admitted, was particularly hard, half of the hubs exhibited very perceptible evidence of wear. At the end of two hours more, a dozen had behaved pretty well, but only two were intact. To carry the test still farther, the hubs that had withstood the preceding work were submitted to a double speed under the same load. None of them was able to withstand several hours' work, and this seems to prove that although the present bicycle hubs are sufficiently well constructed for a load of from 65 to 90 pounds at speeds of from 15.5 to 18.5 miles an hour, they would be unable to withstand heavier loads at much greater speeds.

This ingenious machine, moreover, permits of demonstrating that the rolling wear is much more marked at high than at low speeds, and that a hub is more greatly strained, for example, after a run of 620 miles at the rate of 31 miles an hour than after effecting a longer trip at a speed of but from 12.5 to 15.5 miles. —For the above description and the engravings we are indebted to La Nature.

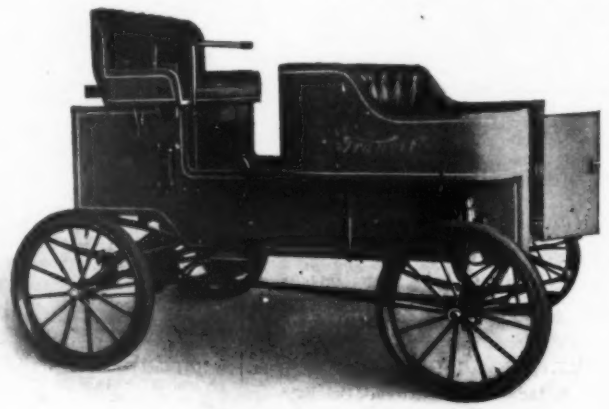
A STEAM AUTOMOBILE OF NOVEL DESIGN.

Now that the attention of automobile manufacturers has been turned from the production of racing machines to the manufacture of pleasure carriages, the accompanying illustrations will be of interest as showing a distinctly American design of the latter type of vehicle. Instead of placing the passenger compartment behind the driver and machinery, as is done in the well-known tonneau body of the French, Mr. W. S. Rogers, the designer of this automobile, has placed it in the front, and set the driver on a slightly elevated seat at the rear. The advantages of this arrangement are obvious. The passengers not only have an unobstructed view, but, by their position, they are well out of the way of dust or mud thrown up by the wheels of the vehicle, besides being in front of, and hence well insulated from, the noise and odors of the machinery.

The front compartment can be changed and a parcel delivery box substituted if the owner wishes to use the carriage as a delivery wagon.

This type of body is placed on the new vehicles of the Steamobile Company, of Keene, N. H. The carriage weighs 1,400 pounds. It is provided with steel tube wheels, and by removing the pneumatic tires it can be run on the rails of an ordinary railroad track, so that in the hands of a railroad man, it could serve the double purpose of pleasure vehicle and inspection car.

From the above description it will be seen that the chief claim to novelty in this car lies in its peculiar form of body, in the rear of which is incased the engine, boiler, and water-tank of the usual steam carriage. These are of first-class design and workmanship, as are all the other appointments on the Steamobile Company's vehicles.



THE STEAMOBILE COMPANY'S NOVEL FAMILY CARRIAGE.

A NOVEL FAMILY CARRIAGE—REAR VIEW.

ARTIFICIAL SILK.*

CHARDONNET PROCESS OF MAKING IT.

THE high cost of natural silk has always been an incentive to inventors in their search for a substitute that would possess the strength and luster of the natural product. The first patent for artificial silk was issued in 1885, and samples were exhibited at the Paris Exposition in 1889.

Many difficulties were met with at first. The highly explosive and inflammable character of the material was one of the greatest objections. This defect has been remedied by the process of treating the silk with a cupric ammonia solution and then in phosphate of ammonia. This process reduces the inflammability of artificial silk below that of cotton. Companies in both France and Germany are engaged in the manufacture of the artificial product, and as the price was much below that of natural silk, while the luster was even higher, a ready market was found for all that could be produced.

To offset the advantages that we have named, artificial silk possesses certain defects. The dry artificial silk possesses less than half of the strength and considerably less elasticity than true silk. For this reason its use has been confined to the weft of goods with a warp of natural silk, mercerized cotton, or worsted. It is used extensively in the manufacture of the stuffs, novelty goods, decorations, and passementerie. Still more objectionable is the lack of strength. The tendency of artificial silk when wet is to disintegrate like wet paper. For this reason great care is necessary in dyeing and washing the material. Experiments made to determine the effect of various solutions on artificial silk gave the following results:

1. A sample of Chardonnet silk was boiled one hour in distilled water. Upon taking the sample out, it was found to be soft, and it parted when subjected to a slight tension.

2. A sample of artificial silk was steeped one hour in a strong solution of acetic acid. The result was similar to that of No. 1 test. When dry the silk possessed the well-known quality called scroop caused by the acid. This scroop was, however, much less than is found in natural silk.

3. A treatment in benzine for one hour caused no change other than that the fiber appeared somewhat harsher after the benzine evaporated.

The following methods are employed for distinguishing Chardonnet artificial silk from natural silk:

a. A yellow color is imparted to the liquor when the artificial product is dissolved in an alkaline solution. In the case of natural silk the liquor is colorless.

b. Artificial silk burns quickly in a flame, and very little ash remains. True silk carbonizes when burned.

c. Artificial silk is reddened when treated first with sulphuric acid and afterward with brucine; a small quantity of diphenylamine causes a blue color, since nitric acid is always present in the fiber.

d. Natural silk is dissolved in a solution of 10 grammes of sulphate of copper and 5 grammes of glycerine in 100 centimeters of water, to which sufficient alkali is added to dissolve the resulting deposit. Artificial silk is not soluble in this solution.

By far the largest part of artificial silk is at present manufactured by the Chardonnet process. Recently a new artificial silk, called "glanzstoff," has been put on the market. It is obtained by dissolving cellulose in cupric oxide of ammonia, and possesses considerable luster and strength.

There was exhibited at the Paris Exposition in 1900 an artificial silk, called "viscoid," that possessed many good qualities; this silk has not yet been placed on the market; as its name indicates, it is obtained from viscose.

With the exception of Vandura silk, which is made by treating gelatine with formaldehyde, cellulose is the material from which artificial silk is made. Cotton is nearly chemically pure cellulose, and for this reason the action of dyestuffs and chemicals is much the same on both cotton and artificial silk.

The Chardonnet product, owing to the nitric acid in its manufacture, is much more susceptible to the action of most dyestuffs than is cotton. Thus artificial silk can be dyed with the basic dyes, all shades from

* Boston Journal of Commerce.

the brightest to the darkest without preparation with tannin and antimony salts. As brightness and luster are more important than fastness in the dyeing of artificial silk, the basic dyes are specially adapted for this material. The dyeing process is simple and sure. Acetic acid is added to the bath and the material entered cold. This liquor is heated gradually, the fiber absorbs the liquor quickly, and the color develops very evenly. Although, as already observed, the wetting of artificial silk reduces its strength, there is not much danger in this respect if the material is handled carefully.

The substantive dyes rank next to basic dyestuffs for dyeing artificial silk. For the dark shades the material is entered cold in a soap bath containing common or Glauber salt. The artificial silk absorbs the substantive dyes more readily than does cotton, otherwise the action is the same. Owing to the reduction of the strength of artificial silk when wet, great care must be used in handling the material when in this state. Violent boiling should be avoided, and after rinsing it is best to extract the material with rubber rolls under light pressure. Sulphur colors are less used for coloring artificial silk, as the shades obtained are duller and the fastness of the substantive dyes answers every purpose. The use of mordant dyes is excluded, because all mordants injure the luster of artificial silk.

The price of Chardonnet silk has hitherto averaged about $2.20 per pound, and recently was advanced to $2.30. The price will probably decline in the future, as many new establishments for producing artificial silk will doubtless play an important part in the textile industry.

PORTABLE FOLDING STAIRS.

THE folding stairs devised by M. Gallice are designed to facilitate passengers getting on and off boats and cars, and they can be employed in all cases where between the wharf and the boat or the platform and the car there exists a space to be crossed either upwardly or horizontally.

The apparatus may be used as a flight of stairs when partially unfolded, or as a footbridge when fully extended. When folded up, it occupies but little space (Fig. 2).

In Fig. 1 it is seen in use in connection with an ordinary carriage for facilitating the exit of an invalid or infirm person. The same type may be applied to a railway car.

On board of a yacht it may be used as a gangplank to permit of reaching the shore without having recourse to a rowboat.

The present models are constructed entirely of metal. That for carriages is provided in most cases with steps 5 or 6 inches in width and sufficiently extensible to reach the height of 25 inches that usually separates the floor of the vehicle from the ground. The boat type for the use of heavy persons is naturally made a little more rigid. All the types are easily mounted and dismounted. They are made either with or without hand railings, and their arrangements may be varied as may be desired.

For landaus there are elegant models, which have steps made of imitation mahogany, and on which the ironwork is bronzed or japanned.

FIG. 1.—FOLDING STAIRS ADAPTED TO A CARRIAGE.

FIG. 2.—PORTABLE STAIRS FOLDED UP.

PROTECTION AGAINST BURGLARS.

THE true means of defense against the professional burglar are now found only in the application of what may be called scientific processes.

A daily experience with the habits of burglars and their manner of operating, along with a profound knowledge of the various means employed for preventing their depredations, have led M. Defert, a specialist, to devise an apparatus that would seem as if it ought to remedy the evil in a large measure. M. Defert's invention consists in a combination of a tumbler and manifold bolts that is in nowise distinguishable from an ordinary lock at a first glance. Its operation, besides, requires no special attention on the part of the tenant of a flat; but, in the interior, a very ingenious mechanism permits the janitor to follow upon a board placed in his office all the incomings and outgoings of the persons belonging to the house. When the tenant, upon leaving his apartments, closes his door behind him, an automatic electric device in the office causes the appearance of the word "out" accompanied with the stroke of a gong. When he returns and opens his door, the word "in" makes its appearance.

Let us suppose that a burglar introduces himself into the house and gives the janitor the name of some other tenant than the one whose apartment he wishes to explore. Even though he has obtained the key of his intended victim or one identical with it, it is possible for the janitor to have knowledge of the apartment that the visitor has entered at the moment at which the gong sounds. If he uses false keys, so much the better. The tool with which he endeavors to pick the lock, in rubbing against certain pieces placed in the interior of the lock, unites the currents and his attempt is made known on the ground floor by the ringing of an alarm bell.

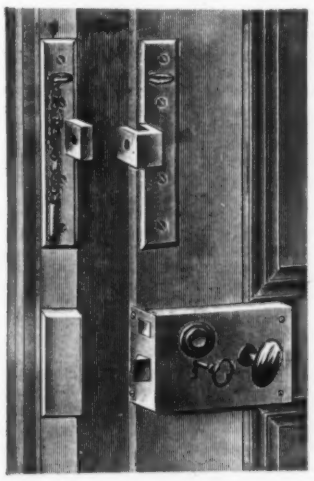
Another method, no less efficient, but relatively dangerous, consists in the use of apparatus that set fire arms in action. There are mechanisms of this kind, which, like the Defert apparatus, actuate alarm bells, but which at the same time cause the explosion of detonating cartridges that may be used with perfect safety. A detonating lock devised of M. Paul Blanchet of this kind is represented in Fig. 1. It is a safety lock analogous to the one employed by M. Defert. Like the latter, it contains a piece that oscillates when an attempt is made to introduce a false key into the lock. When an attempt is made to force the door, the pressure upon the latter causes a play of the bolt that produces an oscillation of the piece. In both cases, this oscillating motion uncocks a hammer that strikes a cartridge and causes a loud detonation. It will be seen that the same mechanism is capable of producing an electric contact and causing the ringing of an alarm bell. It is possible to apply such a mechanism to all the window fastenings and door bolts of a house. In the latter case, it is possible to place the alarm bells or cartridges wherever it may be desired, and, if it is a question of an isolated villa, to ring a bell or explode a large cartridge placed upon the top of the building.

In many cases, however, it is unnecessary to convert one's apartments into a true citadel; for good strong locks completed by special arrangements will suffice to baffle the attempts of the housebreaker.

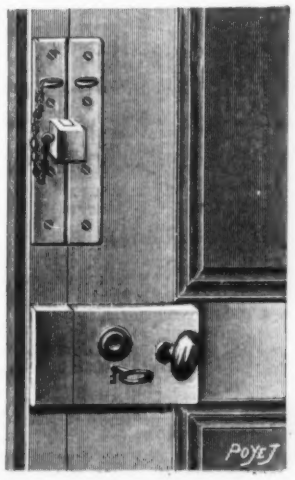
In some instances, a simple safety bolt, provided it be placed far enough from the lock, constitutes along with the latter an adequate protection. The bolt itself may be replaced by an arrangement of extreme simplicity invented by M. Vaché and represented in Fig. 2.

The apparatus consists of two bronze plates, one of which is screwed to the door frame, and the other to the door itself. The stationary plate carries a tongue and the movable one a socket into which the forme enters when the door is closed; so that it becomes impossible to separate the door from its frame by the introduction of a jimmy or wedge. A sufficient play exists between the tongue and socket to permit of a free motion of the door. The tongue and socket are provided with an aperture into which may be inserted a small bolt suspended at the side by means of a chain. For the above particulars and the engravings, we are indebted to L'Illustration.

FIG. 1.—THE BLANCHET DETONATING LOCK.



OPEN.



CLOSED.

FIG. 2.—THE VACHE "ANTI-BURGLAR" DOOR FASTENING.

FOOD AS BUILDING MATERIAL AND FUEL.*

By W. O. ATWATER, Ph.D.

BLOOD and muscle, bone and tendon, brain and nerve—all the organs and tissues of the body—are built from the nutritive ingredients of food. With every motion of the body, and with the exercise of feeding and thought as well, material is consumed and must be resupplied by food. In a sense, the body is a superior machine. Like other machines, it requires material to build up its several parts, to repair them as they are worn out, and to serve as fuel. In some ways it uses this material like a machine; in others it does not. The steam engine gets its power from fuel; the body does the same. In the one case coal or wood, in the other food, is the fuel. In both cases the energy which is latent in the fuel—the potential energy, as it is called in scientific language—is transformed into heat and power. When the coal is burned in the furnace a part of its potential energy is transformed into the mechanical power which the engine uses for its work; the rest is wasted in the heat which the engine does not utilize. Likewise the potential energy of food is transformed in the body into heat and mechanical power. The mechanical power is employed for muscular work. The heat is used to keep the body warm, and when more is generated than is needed for that purpose it is wasted, as in the case of the engine.

One important difference between the human machine and the steam engine is that the former is self-building, self-repairing, and self-regulating. Another is that the material of which the engine is built is very different from that which it uses for fuel, but part of the material which serves the body for fuel also builds it up and keeps it in repair. Furthermore, the body can use its own substance for fuel. This the steam engine can not do. The steam engine and the body are alike in that both convert the fuel into heat and mechanical power. They differ in that the body uses the same material for fuel as for building, and also consumes its own material for fuel. In the use of fuel the body is much more economical than any engine.

But the body is more than a machine. It has not simply organs to build and keep in repair and supply with energy; it has a nervous organization; it has sensibilities; and there are the higher intellectual and spiritual faculties. The right exercise of these depends upon the right nutrition of the body.

The chief uses of food, then, are two: (1) To form the material of the body and repair its wastes, and (2) to yield heat to keep the body warm and furnish muscular and other power for the work it has to do. In forming the tissues and the fluids of the body the food serves for building and repair. In yielding heat and power it serves as fuel.

If more food is eaten than is needed, more or less of the surplus may be and sometimes is stored in the body, chiefly in the form of fat. The fat in the body forms a sort of reserve supply of fuel and is burned in the place of food. When the work is hard or the food supply is low the body draws upon this store of fat and grows lean.

PROTEIN AS BUILDING MATERIAL.

The principal tissue formers are the protein compounds, especially the albuminoids. These make the framework of the body. They build up and repair the nitrogenous materials, as the muscles and tendons, and supply the albuminoids of the blood, milk and other fluids.

The albuminoids of food are transformed into the albuminoids and gelatinoids of the body. Muscle, tendon and cartilage, bone and skin, the corpuscles of the blood, and the casein of milk are made of the albuminoids of food. The albuminoids are sometimes called "flesh formers" or "muscle formers," because the lean flesh, the muscle, is made from them, though the term is inadequate, as it leaves out of account the energy-furnishing function of protein. The gelatinoids of food, such as the finer particles of tendon and the gelatin, which are dissolved out of bone and meat in soup, though somewhat similar to the albuminoids in

* From Farmers' Bulletin No. 142, United States Dept. of Agriculture.

composition, are not believed to be tissue formers; but they are valuable in protecting the albuminoids from consumption. That is, when the food contains gelatinoids in abundance less of albuminoids is used.

The proteids can be so changed in the body as to yield fats and carbohydrates, and such changes actually occur to some extent. In this and other ways they supply the body with fuel.

The protein compounds are not only used for building and repairing tissue, but are also burned directly in the body like the carbohydrates, and thus render important service as fuel. A dog can live on lean meat. He can convert its material into muscle and its energy into heat and muscular power. Man can do the same; but such a one-sided diet would not be best for the dog and it would be still worse for man. The natural food for carnivorous animals, like the dog, supplies fats and some carbohydrates, and that for omnivorous animals, like man, furnishes fats and carbohydrates in liberal amounts along with protein. Herbivorous animals, like horses, cattle, and sheep, naturally require large proportions of carbohydrates.

FATS AND CARBOHYDRATES AS FUEL.

Fats and carbohydrates are the chief fuel ingredients of food. Sugar and the starch of bread and potatoes are burned in the body to yield heat and power. The fats, such as the fat of meat and butter, serve the same purpose, only they are a more concentrated fuel than the carbohydrates.

The body transforms the carbohydrates of food into fat. This fat, and with it that stored from the food, is kept in the body as reserve fuel in the most concentrated form.

The different nutrients can to a greater or less extent do one another's work. If the body has not enough of one kind of fuel it can use another. But, while protein can be burned in the place of fats and carbohydrates, neither of the latter can take the place of the albuminoids in building and repairing the tissues. At the same time the gelatinoids, fats, and carbohydrates, by being consumed themselves, protect the albuminoids from consumption.

VALUE OF FOOD FOR SUPPLYING ENERGY.

Heat and muscular power are forms of force or energy. The energy latent in the food is developed as the food is consumed in the body. The process is more or less akin to that which takes place when coal is burned in the furnace of the locomotive. For the burning of the food in the body or the coal in the furnace, air is used to supply oxygen. When the fuel is oxidized, be it meat or wood, bread or coal, the latent energy becomes active, or, in technical language, the potential energy becomes kinetic; it is transformed into heat and power. As various kinds of coal differ in the amount of heat given off per ton, so various kinds of food and food ingredients give off different amounts of energy; that is, have different values as fuel in the body.

HEAT OF COMBUSTION.

The process of oxidation of material and transformation of energy in the body are less simple than in the engine and less clearly understood. Late research, however, has given us ways of measuring the energy latent in coal, wood, and in food materials as well. This is most generally done in the chemical laboratory by an apparatus called the bomb calorimeter. The amount of heat given off in the oxidation of a given quantity of any material is called its "heat of combustion," and is taken as a measure of its latent or potential energy. The unit commonly used is the calorie, the amount of heat which would raise the temperature of 1 kilogramme of water 1 deg. C., or, what is nearly the same thing, 1 pound of water 4 deg. F. Instead of this unit of heat a unit of mechanical energy may be used—for instance, the foot-ton, which represents the force required to raise 1 ton 1 foot. One calorie is equal to very nearly 1.54 foot-tons; that is to say, 1 calorie of heat, when transformed into mechanical power, would suffice to lift 1 ton 1.54 feet.

THE CONSERVATION OF ENERGY IN THE BODY.

The amounts of energy transformed in the body when food and its own material are burned within it are measured with the respiration calorimeter referred to. It is well known that the food is not completely oxidized in the body. These experiments have shown that the material which is oxidized yields the same amount of energy as it would if burned with oxygen outside the body, e. g., in the bomb calorimeter. The experiments show also that when a man does no muscular work (save, of course, the internal work of respiration, circulation, etc.), all the energy leaves his body as heat; but when he does muscular work, as in lifting weights or driving a bicycle, part of the energy appears in the external work thus done, and the rest is given off from the body as heat. The most interesting result of all is that the energy given off from the body as heat when the man is at rest, or as heat and mechanical work together when he is working, exactly equals the latent energy of the material burned in the body. This is in accordance with the law of the conservation of energy. It thus appears that the body actually obeys, as we should expect it to obey, this great law which dominates the physical universe.

FUEL VALUE.

We may make practical application of this principle of the conservation of energy in the body in measuring the actual value of food as fuel to the body, i. e., its "fuel value," by use of the bomb and respiration calorimeters. To do this we have to take into account the chemical composition of the food, the proportions of the nutrients actually digested and oxidized in the body, and the proportion of the whole latent energy of each which becomes active and useful to the body for warmth and work. Taking our common food materials as they are used in ordinary diet, the following general estimate has been made for the energy furnished to the body by 1 gramme or 1 pound of each of the classes of nutrients:*

Protein, fuel value, 4 calories per gramme, or 1,820 calories per pound.
Fats, fuel value, 8.9 calories per gramme, or 4,040 calories per pound.
Carbohydrates, fuel value, 4 calories per gramme, or 1,820 calories per pound.

It will be seen that when we compare the nutrients in respect to their fuel value, their capacities for yielding heat and mechanical power, a pound of protein of lean meat or albumen of egg is just about equivalent to a pound of sugar or starch, and a little over 2 pounds of either would be required to equal a pound of the fat of meat or butter or of body fat.

The fuel value of food obviously depends upon the amounts of actual nutrients, and especially upon the amount of fat it contains. Thus a pound of wheat flour, which consists largely of starch, has an average fuel value of about 1,625 calories, and a pound of butter, which is mostly fat, about 3,410 calories. These are only about one-eighth water. Whole milk, which is seven-eighths water, has an average fuel value of 310 calories per pound; cream, which has more fat and less water, 865 calories, and skim milk, which is whole milk after the cream has been removed, 165 calories.

This high fuel value of fat explains the economy of nature in storing fat in the body for use in case of need. Fat is the most concentrated form of body fuel.

We have been considering food as a source of heat and muscular power. There is no doubt that intellectual activity, also, is somehow dependent upon the consumption of material which the brain has obtained from the food; but just what substances are consumed to produce brain and nerve force, and how much of each is required for a given quantity of intellectual labor, are questions which the physiological chemist has not yet answered.

HOW THE FUNCTIONS AND NUTRITIVE VALUE OF FOOD ARE LEARNED.

The principles above explained are based upon a great deal of experimenting and observation. The experimenting is of many kinds, but of especial importance is the work with the respiration apparatus and respiration calorimeter.

Various forms of respiration apparatus have been devised within the last fifty years. Among the most important are those invented by Pettenkofer and Voit in Munich. They consist of metal-walled chambers large enough for the subject (sometimes a man, sometimes a dog, sheep, or other animal) to live in comfortably for several days, and are furnished with devices for pumping air through and measuring and analyzing it as it enters and leaves the chamber. With such an apparatus it is possible not only to measure all the food and excreta, but also the materials given off from the lungs in the breath, and to make accurate determinations of the matter entering and leaving the body.

A still more elaborate apparatus, by which not only all the matter passing in and out of the body may be measured, but also all the heat given off from it, is called a respiration calorimeter—that is, a machine for measuring both the respiratory products and the heat given off by the body. It is like the respiration apparatus, except that it is furnished with devices for measuring temperatures. Several have been built in Europe within the last twenty years, among the most successful being those by Rubner and Rosenthal.* Investigations in co-operation with the United States Department of Agriculture are now being carried on in one recently built by the author and Prof. Rosa at Wesleyan University.† Its main feature is a copper-walled chamber 7 feet long, 4 feet wide, and 6 feet 4 inches high. This is fitted with devices for maintaining and measuring a ventilating current of air, for sampling and analyzing this air, for removing and measuring the heat given off within the chamber, and for passing food and other articles in and out. It is furnished with a folding bed, chair, and table, with scales and with appliances for muscular work, and has telephone connection with the outside. Here the subject stays for a period of from three to twelve days, during which time careful analyses and measurements are made of all material which enters the body in the food and of that which leaves it in the breath and excreta. Record is also kept of the energy given off from the body as heat and muscular work. The differences between the material taken into and that given off from the body is called the balance of matter, and shows whether the body is gaining or losing material. The difference between the energy of the food taken and that of the excreta and the energy given off from the body as heat and muscular work, is the balance of energy, and if correctly estimated should equal the energy of the body material gained or lost.

With such apparatus it is possible to learn what effect different conditions of nourishment will have on the human body. In one experiment, for instance, the subject might be kept quite at rest, and in the next do a certain amount of muscular or mental work, with the same diet as before. Then by comparing the results of the two the use which the body makes of its food under the different conditions could be determined. Or the diet may be slightly changed in one experiment and the effect of this on the balance of matter and energy observed. Such methods and apparatus are very costly in time and money, but the results are proportionately more valuable than those from simpler experiments.

Digestive Tablets.—

Powdered double refined sugar	300 parts
Subnitrate bismuth	60 parts
Saccharated pepsin	45 parts
Pancreatine	45 parts
Mucilage	35 parts
Ginger	30 parts

Mix and divide into suitable sizes.—Pract. Drug.

*These estimates are based upon the latest and most reliable research and take into account only the material which is digested and oxidized so that its energy is actually available to the body. Earlier estimates, based on less accurate data and not making allowance for the amounts of fats and carbohydrates which escape oxidation in the body, give 4.1 calories per gramme, or 1,860 calories per pound, for protein and carbohydrates and 9.3 calories per gramme, or 4,220 for fats—figures which have come into common use.

* U. S. Dept. Agr., Office of Experiment Stations Bul. 21, p. 133.

† U. S. Dept. Agr., Office of Experiment Stations Bul. 63.

SELECTED FORMULÆ.

Salad Cream.—

Salt	2 drachms
White sugar	1 ounce
Best olive oil	2 ounces
Two eggs	

Make an emulsion of above and add it to the following ingredients, previously mixed:

Tincture cayenne	20 drops
Mustard	1 ounce
Malt vinegar	6 ounces

—B. and C. Drug.

Camphor Pomade.—

Oil bitter almonds	1 drachm
Oil cloves	20 drops
Camphor	1½ ounces
White wax	4 ounces
Lard, prepared	1 pound

Melt the wax and lard together, then add the camphor in saturated solution in spirit; put in the oils when nearly cold.—Pract. Drug.

Insect Powder.—The following is claimed to be especially destructive to water-bugs and cockroaches:

Persian insect powder	8 ounces
Borax	8 ounces
Sulphur	4 ounces
Oil eucalyptus	2 drachms

—Pract. Drug.

Violet Vinegar.—

Extract cassia	1 ounce
Extract orris	½ ounce
Extract rose triple	½ ounce
White vinegar	4 ounces

Mix. Let stand for a week, and filter.—Pract. Drug

Universal Cleaner.—

Green soap	20-25 parts
Boiling water	750 parts
Liq. ammon., caustic	30-40 parts
Acetic ether	20-30 parts

Mix.—Jour. de Phar.

Rose Poudre de Riz.—

I.

Corn starch	9	pounds
Powdered talc	1	pound
Oil of rose	80	drops
Extract musk	2	drachms
Extract jasmine	6	drachms

II. (Cheaper.)

Potato starch	9	pounds
Powdered talc	1	pound
Oil rose	45	drops
Extract jasmine	½	ounce

Compound Sirup of Iron (Swiss).—

Ferrated extract apples	1 part
Cinnamon water	4 parts
Sirup orange peel	20 parts
Sirup	24 parts
Sirup rhubarb	50 parts
Tincture cinnamon	1 part

Beetle Powder.—

Cocoa powder	4 ounces
Starch	8 ounces
Borax	37 ounces

Mix thoroughly.—Pract. Drug.

Inhalant for Cartarrh.—

Carbolic acid	15 ounces
Glycerin	2 drachms
Tincture iodine	4 drachms
Camphor, powder	10 ounces
Oil wintergreen	5 drops
Water of ammonia sufficient.	

Triturate the carbolic acid and camphor together until liquefied, add the glycerin, iodine and oil, and then add sufficient ammonia until the mixture is colorless.—Pract. Drug.

Mueller's Dentifrice.—

Thymol	2 grains
Benzoic acid	24 grains
Tincture eucalyptus	2 drachms
Alcohol, q. s. ad	2 ounces

Mix. Sig. A teaspoonful diluted with half a wineglassful of water.—Polyclinic.

Liquid Dentifrice.—A preparation which has a considerable reputation in France as a liquid dentifrice is stated to be composed of alcohol, 96 per cent, 1,000; Mitcham peppermint oil, 30; aniseseed oil, 5; oil of Acorus calamus, 0.5. Finely powdered cochineal and cream of tartar, of each 5, are used to tint the solution. The mixed ingredients are set aside for fourteen days before filtering.—Phar. Post.

Cod Liver Oil Emulsion.—Prof. Zoliette gives the following formula: Mix 190 grammes of powdered sugar with 5 grammes of acacia and 500 grammes of tragacanth in a mortar. Mix in a large bottle and shake thoroughly together 500 grammes of cod liver oil and 200 grammes of a cold infusion of coffee. Gradually add a part of this mixture to the powder in the mortar and triturate until emulsified. To the remaining liquid mixture add 100 grammes of rum, then gradually incorporate with the contents of the mortar by trituration.—Bull. de Ther.

Baer's Antiseptic Bromine Solution.—

Bromine	1 ounce
Sodium chloride	8 ounces
Water	8 pints

Dissolve the sodium chloride in the water and add the bromine. This solution is to be diluted when applied to broken skin surfaces, 1 part with 15 parts of water.—Pract. Drug.

Violet Talc.—

Powdered talc	14	ounces
Powdered orris root	2	ounces
Extract cassie	½	ounce
Extract jasmine	¼	ounce
Extract musk	1	drachm

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

The Timber Market in China.—I am convinced that the future demand in China for Pacific coast lumber will be both extensive and permanent.

For more than 1,000 miles up the great valley of the Yangtze there is practically no timber in sight. The plains, hills, and mountains are absolutely bare of forestry, except where, here and there, a few trees have been carefully preserved.

South of the Yangtze, there is some timber to be found on the Min River, in the province of Fukien, but it is mostly a young growth of poor pine. North of the great river, there is no timber until the Yalu River, which forms the boundary between Korea and Manchuria, is reached. In the Yangtze Valley, the only available timber is far up the River Han, on the north side, and along the head waters of the streams in the province of Hunan, on the south. This timber is floated in great log rafts down the river to the market at Hankau. It is mostly a soft pine, of small bulk and young growth.

A hard wood, very much resembling ash, comes from the provinces north of Hupeh, and is extensively used in the manufacture of guns at the great Hankau arsenal.

A considerable quantity of timber is brought into China from Korea by the Chinese junks, which sail along the coast and up many of the rivers. Most of it consists of fir and soft pine logs, flattened, squared, or round. It is afterward cut up by the usual whip-saw process in vogue in China. In many instances, the contractor buys the logs and has them carried to the building he is erecting, where he cuts the lumber to suit his requirements.

Japan also furnishes a large amount of timber to China, and in the market for railroad ties or sleepers is the main competitor of the Pacific coast of the United States. The Japanese ties are both hewn and sawn, and are mostly of a hard wood resembling oak, but rather brash and easily broken. They appear to make a good railroad tie, although there is some complaint that they do not last long. It is thought, however, that this defect could easily be remedied by cutting down the trees at the time of the year when they contained the least sap. These ties come from Hokkaido, the northern island of Japan.

On the island of Sakhalin, the great penal colony of Russia, there is another possible supply of large quantities of timber for the markets of China. This island has splendid forests of fir and pine.

For furniture and interior finish, a hard red wood known as teak is extensively used. This and similar timber is brought in considerable quantities to China from the Philippines and other southern islands. These are exceptionally fine woods, but are becoming expensive.

USES OF LUMBER IN CHINA.

In China, probably more wood is used for coffins than for any other purpose. The coffins are made of lumber from 4 to 10 inches thick. It is not a high estimate to say that from 8,000,000,000 to 10,000,000,000 feet of lumber are annually thus utilized.

The great majority of houses are built of mud and bricks, or mud and straw or millet stalks; very little lumber is used. The roofs are made of either tiles or straw and mud.

Next to coffins, the greatest use for lumber in China is for boats. While there are no statistics on the subject, it is safe to say that the number of craft runs into the millions. The vast coast line, the enormous rivers, the wonderful canal systems of China are all teeming with boats of every description, propelled by steam, sail, towline, or oars operated by both hand and foot. Through vast areas of country, rivers and canals form the only highway; in some sections, they are more numerous than the common roads in the most densely populated agricultural districts of the United States.

Enormous quantities of wooden buckets and small wooden tubs are used in every district in China; in my opinion, material for the manufacture of these articles could be secured from the slabs that are now wasted in Oregon and Washington sawmills. Oregon pine would make most satisfactory buckets and tubs for Chinese use.

SAWMILLS IN CHINA.

I have been able to locate only two mills in all of China. One is near Fuchau, and has but a small capacity; the other is at Niuchwang, and has just been started. The latter is a small, single circular-saw mill, which cuts about 2,000 feet a day. This mill was imported from Michigan, and seems to meet the requirements. I believe that a good many of these small mills can be sold in China; certainly, a number could be used to advantage at Tientsin, Shanghai, Hankau, and other places. Cheap mills, built for cutting a few thousand feet of light logs a day, would be the most likely to meet with sale.—**Henry B. Miller, Consul at Niuchwang.**

American Gas Coal in Denmark.—I give below the report (translated) of the results of a trial of American coal at the Copenhagen gas works.

This coal was used for twenty-four hours on the 1st of March in the production of gas in retort house No. 1, with the following results: Quantity of coal used, 144.14 tons; gas produced, 1,599,300 cubic feet; gas produced by each ton of coal, 11,091 cubic feet; power of the gas, 16.52 Hefner light (76 Omm. 15 deg. C.); coke resulting from each ton of coal, 16.37 pounds; ashes in the coke, 7¼ per cent.

The coal was in large pieces, so that, before using, crushing was necessary. One should have machinery for that purpose.

The coke was firm, substantial, and gave a good heat, but left considerable slag in the fire box. We consider the coke good for industrial use. In stoves, it burns well, giving off strong heat, but requires good draft. Regarding the residuum of tar and ammonia water, little can be said from so brief a trial.

As compared with English gas coal, in regard to the production of gas, the American coal stands certainly as high and in some respects higher than the very best.

The result, as regards amount of coke, is like that obtained from good English gas coal, but the quality is somewhat higher.

This coal must therefore be considered a specially good gas coal.

This coal was sold here at 20s. ($4.86) per ton c. i. f. With better shipping arrangements and larger cargoes, this price can undoubtedly be much reduced. Two cargoes of Canadian coal of 5,000 tons each have just been sold here at 15s. 13d. ($3.63) c. i. f. Such a difference in price is certainly unnecessary.—**J. C. Freeman, Consul at Copenhagen.**

Peat as Fuel for Swedish Industries.—My previous report on this subject* has caused several correspondents to make inquiries about the result of the experiments with peat as fuel for locomotives in Sweden. The question of using peat in industry has for several years received attention. Two or three inventors have tried to solve the question by exposing the peat to strong heat in closed retorts, thus producing a sort of charcoal which was used either in the form of lumps or of powder. In the latter case, special furnaces were required. One factory has two ovens, or furnaces, in the first of which the peat was converted into gases, which were burned in the second furnace, under the boiler. These methods have not come into general use; they were probably found too expensive.

Swedish engineers have studied the manufacture of peat briquettes in Germany, and the present tendency here is to use common peat, rendered compact and transportable by being pressed by machinery. It is reported that a couple of iron works use peat with good results in the blast furnaces, instead of wood or charcoal. The railroads are also experimenting with this fuel, and it is said with success, though I can not obtain exact figures, as the tests are not yet concluded. It is alleged, however, that the use of peat does not offer any economical advantage; it has been ascertained that 1 pound of peat will produce only 4 pounds of steam, while good English coal will produce from 6 to 7 pounds. Peat costs from $2.68 to $2.95 per ton and English locomotive coal from $3.61 to $4.70 per ton. There is a movement, however, to make peat cheaper by reducing the railroad freight rates for this fuel, and improved methods of manufacture may also lessen the price.

Even if the result of the tests has not proved in all respects satisfactory, it may be inferred that they have been worth the trouble, for the managers of the State railroads have ordered a locomotive built specially for the use of peat. It is reported that the boiler for this locomotive is being constructed by Motala Werkstad, Motala, Sweden; that it is nearly finished, and will be delivered within a few days.—**Robert S. S. Bergh, Consul at Gothenberg.**

Tariff Changes in Colombia.—By a recent decree, the import duties on all merchandise except alcohol and rum have been increased 50 per cent over those previously in force; in other words, the ad valorem duty has been raised from 20 per cent to 30 per cent.

The import duty on alcohol and rum has been reduced, in consideration of the facts that the disturbed condition of the Department of Panama has put a stop to the manufacture of these articles and that they form the raw material of other industries which contribute to the wealth of the country. The duty on alcohol and rum is therefore henceforth, and until public order has been restored, as follows:

	Centavos.
For each liter of alcohol containing up to 42 deg. of the areometer of Cartier	50
For each liter of alcohol of more than 42 deg. of the same areometer	100
For each liter of rum up to 21 deg. of the same areometer	50

I may add that the above duty is payable in silver coin, and that gold is now and has been for some months sold for silver at a premium of 150 per cent.†—**Oscar Malmros, Consul at Colon.**

Apples in China.—Consul Miller writes from Niuchwang, January 25, 1902, to the editor of an Oregon newspaper (to whom advance copy of the report has been sent) in regard to the export of apples from the Pacific coast to the Orient. The consul instances a shipment of fifty boxes of apples, which were sent from Portland on September 28, 1901, and reached Niuchwang November 10. They were packed in ordinary light 10 by 11 by 22-inch boxes, cleated on both sides, and the apples were wrapped in paper. The packages held in good shape, and every box arrived intact. The percentage of loss was greatest with the Red Russian variety (75 per cent) and least with the Ben Davis (2 per cent); the Spitzenberg lost 10 per cent, and the Shannon Pippin 25 per cent, and the Jonathan 50 per cent. California ships a quantity of third-grade yellow Newtons to China. Some of these, says Mr. Miller, are consumed by foreigners, but most of them go to the Chinese fruit stands and restaurants and are eaten by natives. The Chinese appetite for fresh fruit is strong, and apples are in great favor; the only obstacle to the creation of a large market is the inability of the masses to purchase. The average Chinaman does not distinguish the different varieties of apples, and if inferior grades could be sent at low rates an extensive outlet could be created. Northern routes are the best for shipping green fruits. All shipments of apples for the northern ports of China should be sent by October 1, on account of the danger of freezing if they arrive late in the season. If the fruit reaches North China in good condition, it will keep well on account of the dry, cold climate. The presence of the Russians in Vladivostock, Port Arthur, and Dalny will increase the market for our apples, as the Russians like this fruit very much.

New German Meat Inspection Law ‡—It is officially announced in the Reichsanzeiger that paragraph 21 of the new law regulating the inspection of cattle intended for slaughter and inspection of meat will go into force on October 1, 1902.

This paragraph provides that no substances or processes of any kind shall be applied to the preparation of meat intended for sale which shall make it injurious to health. The importation of such prepared meat from a foreign country is forbidden and no traffic in it is permitted.

The chemical substances which are considered deleterious are: Boracic acid and its salts; formaldehyde, alcali hyrooxie or carbonate; sulphuric acid and its salts, as well as hyposulphites; fluor acid and its salts; salicylic acid and its combinations; and chloric acid salts.

These provisions of the law also apply to the use of coloring stuffs for meats and meat products. However, the yellow colorings of margarin and the colors applied to the coverings of sausages are excepted.—**Talbot J. Albert, Consul at Brunswick.**

Imitations of American Sheeting in Turkey.—Consul Norton writes from Harput, February 26, 1902:

Referring to reports on the opening for American cotton fabrics here, written under the dates of October 12, 1901, and January 6, 1902,* I would mention the recent appearance in the market of a very clever imitation of the leading brand of American sheeting. The brand in question is the Cabot A, well known and highly valued throughout the Orient. Within a few weeks, merchants here have displayed an imitation, stated to be of Italian manufacture, which has deceived many buyers. The price per piece of 40 yards is $2.52½, as opposed to the current quotations of $3.05 1-3 for the genuine Cabot A. Close inspection is required to detect the inferior quality of the fabric. The trade-mark misleads readily. It reads "Dwright Cabot A," instead of "Dwight Cabot A," while the design of a goat replaces the eagle of the registered trade-mark. I am informed that this article has practically driven the genuine Cabot from the market of Aleppo. This consulate has called attention to the effort at deception, and the manufacturers of the American article have been duly notified, a sample being forwarded to them.

Treatment of Tobacco in British Guiana.—Consul Moulton sends from Demerara, March 7, 1902, copy of an ordinance regulating the treatment of tobacco in that colony, passed by the court of policy at its last session. The ordinance provides that it shall not be lawful to impregnate or weight tobacco with any foreign substance or with water to an extent of more than 5 per cent of the weight thereof at the time of importation, except in premises licensed for the purpose and under the supervision of the comptroller of customs. The penalty for violation of the above is $500. On the removal from licensed premises of any tobacco so impregnated or weighted, there shall be levied thereon as excise duty, if it is imported tobacco, the difference between the duty actually paid and the duty which would be payable if it were then being imported.

Mill Saws in British Columbia.—Under date of April 2, 1902, Consul L. E. Dudley reports from Vancouver:

There seems to be an opening for a manufactory of mill saws in this city. The demand would be large, if the saws manufactured were of approved quality. It is said that Canadian saws are not satisfactory, and that the United States product is imported, although some of them cost $24 each and there is a duty of $8. At this price, there would be a large profit for any manufacturer who would take the trouble to invest here. I shall be glad to procure further information for any person who may desire to consider the subject.

Rum in Spain.—In view of the proposed acquisition of the Danish Antilles and the extension of United States commerce through the West Indies in general, I consider it opportune to call the attention of our merchants to the large trade in this country in West Indian rum, mostly from Jamaica and Martinique. The trade at present is chiefly in the hands of French houses, with agents or branch establishments in Catalonia.

I inclose specimen of a label used on bottles, for the guidance of future importers.† Great importance is attached here to elegance of shape and attractive appearance of bottles, while artistic posters are indispensable in developing business.

Rum up to 22 deg. Cartier pays a duty of 160 pesetas (about $22.20) per hektoliter (26.417 gallons), and the current retail price is 44 pesetas (about $6.20) per case of 12 bottles.

A great many adulterated and imitation rums are offered here, but they are so inferior that they do not interfere much with the sale of the genuine product.—**R. M. Bartleman, Consul at Valencia.**

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* Advance Sheets Nos. 1198 ; Consular Reports No. 256.

† This would make 50 centavos equal to 20 cents in United States currency ; 100 centavos = 40 cents.

‡ Reports on this same subject have been received from Consul-General Guenther, of Frankfort, and Consul Langer, of Solingen.

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* Advance Sheets Nos. 1200 and 1274 ; Consular Reports No. 257.

† Filed in the Bureau of Foreign Commerce, where it may be examined by parties interested.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1333. May 5.—The Motor-boat Exposition at Berlin—High Railway Speed in Germany; Electricity or Steam?—Changes in Australian Tariff—*Demand for Coal-handling Appliances in Lourenco Marquez.

No. 1334. May 6.—Canadian Desire for Tariff Revision—Apricot Kernels in France—Ottoman Railroads—Colombian Tax on Panama Railway Tickets—Hongkong-Wuchan Communication.

No. 1335. May 7.—Trade of China in 1901—American Meat in German Cans.

No. 1336. May 8.—Platinum Mining in British Columbia—Public Works in Tampico, Mexico—Electric Railways in Switzerland.

No. 1337. May 9.—Canal Improvements in France—The Spitzbergen Coal Deposits—American Coal in Egypt—Austrian Demand for Coal—International Congress on Workmen's Dwellings in Düsseldorf—Increase in Railway Rates in Russia—German Interests in Monazite in Brazil—Medical Practice in the Transvaal.

No. 1338. May 10.—American Locomotives in Tunis—The Price of Pork in Germany—Notes from Para—American Enterprise on the River Acre—*Opening for Brewery in Para—*Demand for Liquid Glue in Ireland.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECIPES.

Obtaining and Preserving Grape Juice.—Fruit is likely to be dusty and to be soiled in other ways, and grapes like other fruits should be well washed before using. Leaves or other extraneous matter should also be removed. The juice is obtained by moderate pressure in an ordinary screw press, and strained through felt. By gently heating, the albuminous matter is coagulated and may be skimmed off, and further clarification may be effected by filtering through paper, but such filtration must be done as rapidly as possible, using a number of filters and excluding the air as much as possible.

The juice so obtained may be preserved by sterilization, which is accomplished in the following manner: Put the juice in the bottles in which it is to be kept, filling them very nearly full; place the bottles, unstoppered, in a kettle filled with cold water, so arranging them on a wooden perforated "false bottom" or other like contrivance as to prevent their immediate contact with the metal, this preventing unequal heating and possible fracture. Now heat the water, gradually raising the temperature to the boiling point, and maintain at that until the juice attains a boiling temperature; then close the bottles with perfectly-fitting corks, which have been kept immersed in boiling water for a short time before use.

The corks should not be fastened in any way, as, if the sterilization is not complete, fermentation and consequent explosion of the bottle might occur unless the cork should be forced out.

If the juice is to be used for syrup, as for use at the soda fountain, the best method is to make a concentrated syrup at once, using about 2 pounds of refined sugar to 1 pint of juice, dissolving by a gentle heat. This syrup may be made by simple agitation without heat; and a finer flavor thus results, but its keeping quality would be uncertain.

The juices found in the market are frequently preserved by means of antiseptics, but so far none have been proposed for this purpose which can be considered entirely wholesome. Physiological experiments have shown that while bodies suited for this purpose may be apparently without bad effect at first, their repeated ingestion is likely to cause gastric disturbance.—Drug. Circ. and Chem. Gaz.

Stamping Powder for Embroideries.—"Stamping powders" used for outlining embroidery patterns are made by mixing a little finely-powdered rosin with a suitable pigment. After dusting the powder through the perforated pattern it is fixed on the fabric by laying over it a piece of paper and then passing a hot iron carefully over the paper. By this means the rosin is melted and the mixture adheres.

When white goods are to be "stamped," ultramarine is commonly used as the pigment; for dark goods, zinc white may be substituted.

Especial care should be taken to avoid lead compounds and other poisonous pigments, as they may do mischief by "dusting off."

On velvets or other materials likely to be injured by heat, "stamping" is said to be done by moistening a suitable powder with alcohol and using it as stencil paint. A small addition of resinous matter would seem required here also.—Drug. Circ. and Chem. Gaz.

Vanilla Flavoring.—In confectionery pure crystallized vanillin may be used, according to Schimmel, in the form of a 2½ per cent vanillin sugar which, weight for weight, equals in aroma the best vanilla and should be used in precisely the same manner. To prepare it take of crystallized vanillin 25 grammes, dissolve it in 100 grammes deodorized alcohol, pour this solution upon 975 grammes of sugar, mix it thoroughly. After having evaporated the alcohol in a warm place, and when the sugar has become thoroughly dry, is should be powdered in an earthenware mortar and sifted. It is then ready for use and may be kept an indefinite time without losing aroma. The yellow spots which occur on the sugar after drying are caused by the vanillin. This vanillin-sugar should not be confounded with the vanillin-sugar used by confectioners. The latter may be prepared by adding the necessary amount of sugar to the above 2½ per cent vanillin-sugar.

Borated Talcum.—

Purified talcum, N. F.	2 pounds
Powdered boric acid	1 ounce
To perfume, add the following:	
Powdered orris root	1½ ounces
Extract jasmine	2 drachms
Extract musk	1 drachm

A powder sometimes dispensed under this name is the salicylated powder of talcum of the National Formulary, which contains in every 1,000 grammes 30 grammes of salicylic acid and 100 grammes of boric acid.

Here is a formula which contains zinc oleate:

Zinc oleate	1½ ounces
Boric acid	2½ ounces
Talcum	4 ounces

Mix and perfume if desired.—Pharm. Era.

To Keep Bright Steel and Iron Parts of Machinery —An excellent agent for preserving the brightness of articles, especially parts of machinery, of iron or steel (says the Zeitschrift f. d. Kohlens. Ind.), is a mixture in use in the laboratory of the Bavarian Gewerbemuseums, as follows:

Oil of turpentine	5 parts
Stearin oil	25 parts
Jeweler's rouge	25 parts
Animal charcoal	45 parts

Mix. When required for use, spirits are added until it flows quite easily, and it is then applied with a pencil or brush to the parts to be cleaned. The alcohol soon evaporates, and with a powder made of 45 parts of animal charcoal and 25 parts of rouge, the place is rubbed with a soft cloth. A few rubs leave the surface as brilliant as if just from a buffing wheel.

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TABLE OF CONTENTS.

PAGE

I. ARCHITECTURE.—St. Mark's and St. Antonio's ... 23069

II. AUTOMOBILES.—A Steam Automobile of Novel Design.—2 illustrations ... 23067

III. COMMERCE.—The Principal Vegetable Products of the Hawaiian Islands ... 23065
Weights and Measures used in the Philippines ... 23071
Trade Suggestions from United States Consuls ... 23075

IV. GEOLOGY.—The Dinosaur Beds of the Grand River Valley of Colorado.—By ELMER S. BRIGGS, Ph.D., and OLIVER C. FARRINGTON, Ph.D.—2 illustrations ... 23062

V. ENGINEERING.—New Railroads in Switzerland ... 23067
Ten-ton Hydraulic Graving-dock Crane.—1 illustration ... 23069

VI. MECHANICAL DEVICE.—Machine for Testing Bicycle Hubs.—1 illustration ... 23072
Protection Against Burglars.—3 illustrations ... 23073
Portable Folding Stairs.—2 illustrations ... 23073

VII. MISCELLANEOUS.—London's Latest Census ... 23067
Forerunners of Modern Inventions.—2 illustrations ... 23076
Loss of Life in the United States by Lightning ... 23078
Selected Formulæ ... 23074
Trade Notes and Recipes ... 23076

VIII. NATURAL HISTORY.—The Muskrat—Principal Fur Producer in America ... 23062
Mosquitoes Attracted by Sounds ... 23063

IX. PHYSICS.—Sound Experiments in a Balloon ... 23063

X. PHYSIOLOGY.—Food as Building Material and Fuel.—By W. O. ATWATER, Ph.D. ... 23063

XI. TECHNOLOGY.—The Incandescent Electric Lamp—How Manufactured and Tested.—18 illustrations ... 23064
Industrial Triumphs of Electro-chemistry.—By SAMUEL SHELDON ... 23065
Science in the Theater.—2 illustrations ... 23068
Charlier Oil-fuel Brass Furnaces.—1 illustration ... 23069
Borax and its Manufacture ... 23070
Lac and the Art of Lacquering ... 23071
Artificial Silk ... 23072

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